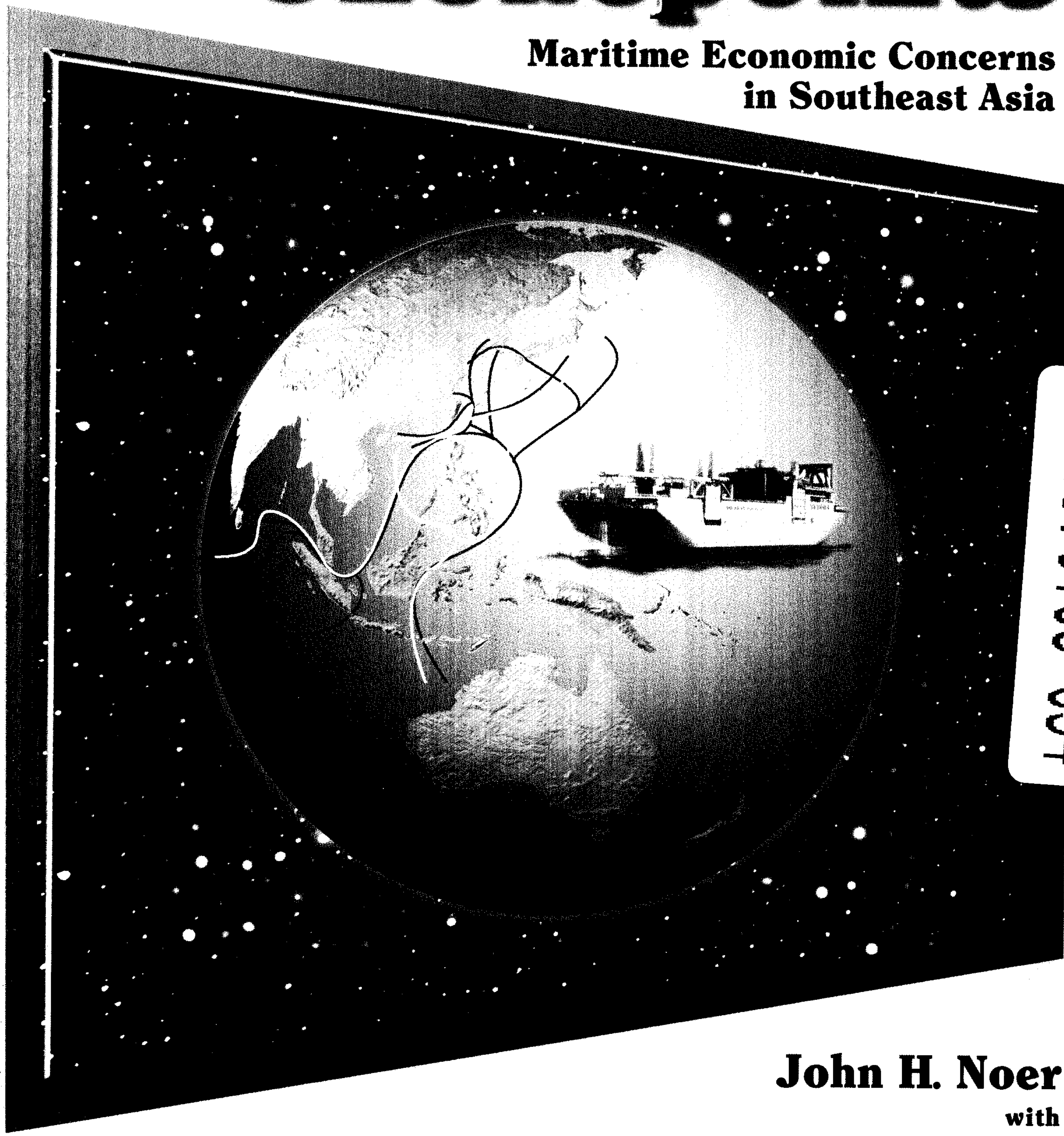
NATIONAL DEFENSE UNIVERSITY
INSTITUTE FOR NATIONAL STRATEGIC STUDIES

Chokepoints

Maritime Economic Concerns in Southeast Asia



John H. Noer
with
David Gregory

Published in Cooperation with the Center for Naval Analyses

The Institute for National Strategic Studies

The Institute for National Strategic Studies (INSS) was established at Fort McNair in Washington, D.C., in July 1984 as an interdisciplinary research institute staffed by senior civilian and military analysts from all four Services. The Director of INSS reports through the President of the National Defense University to the Chairman and Vice Chairman of the Joint Chiefs of Staff, to the Secretary and Deputy Secretary of Defense, and to the Commanders-in-Chief of the Unified Commands. The Institute Director sets the research agenda of the Institute to meet the needs and requirements of the Department of Defense. The Institute performs studies, sponsors visiting research fellows, conducts war games and simulations, stages annual and special conferences, and publishes the results of its research and associated activities.

The Center for Naval Analyses

The Center for Naval Analyses (CNA) is a private, nonprofit, federally funded research and development center in Alexandria, Virginia, that performs independent analyses for the U.S. Department of the Navy. Since 1942, CNA has provided its sponsor with objective analyses and innovative problem solving. In addition to its headquarters operation, CNA maintains a group of more than forty analysts in operational Navy and Marine Corps billets. Through its applied research and policy analysis, CNA assists decisionmakers within the services by conducting a program of rigorous analyses and practical evaluations of naval operations, systems, and programs. CNA also applies its expertise to selected analytical issues facing the Office of the Secretary of Defense and other Defense agencies.

Chokepoints:
Maritime Economic Concerns in Southeast Asia

Chokepoints:
Maritime Economic Concerns in Southeast Asia

Published in Cooperation with the Center for Naval Analyses

John H. Noer
with David Gregory

1996
National Defense University Press
Washington, DC

National Defense University Press Publications

To increase general knowledge and inform discussion, the Institute for National Strategic Studies, through its publication arm, the NDU Press, publishes McNair Papers; proceedings of University- and Institute-sponsored symposia; books relating to U.S. national security, especially to issues of joint, combined, or coalition warfare, peacekeeping operations, and national strategy; and a variety of briefer works designed to circulate contemporary comment and offer alternatives to current policy. The Press occasionally publishes out-of-print defense classics, historical works, and other especially timely or distinguished writing on national security.

Opinions, conclusions, and recommendations, expressed or implied, are those of the authors. They do not necessarily reflect the views of the Center for Naval Analyses, the National Defense University, the Department of Defense, or any other U.S. Government agency. Cleared for public release; distribution unlimited.

Many NDU Press publications are sold by the U.S. Government Printing Office. For information, call (202) 512-1800, or write to the U.S. Government Printing Office, Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402-9328.

Library of Congress Cataloguing-in-Publication Data

Noer, John Halvard, 1949-
Chokepoints : maritime economic concerns in southeast Asia / John H. Noer and David Gregory.
p. cm.
"Published in cooperation with the Center for Naval Analyses."
1. Trade routes--southeast Asia. 2. South China Sea--Strategic aspects. 3. Shipping--South China Sea--Statistics. I. Gregory, David, 1959- . II. Title.
HE882.N64 1996
387.5'1--dc20 96-43271
CIP

First Printing, October 1996

Contents

Tables

Figures

Plates

(following page 54)

Plates 1, 3, 4, 5, and 6 courtesy of the Defense Mapping Agency; Plate 2 courtesy of the National Geographic Society

Foreword

Ever since the opening of trade relations between East Asia and Europe, the narrow sea lanes through the Indonesian archipelago have been of the highest strategic importance to the West and its allies. During the Cold War, maintaining freedom of navigation through the region was a key mission for U.S. forces both to allow transit of friendly warships and to protect commercial traffic. Since the collapse of the Soviet Union, the region's military importance has waned, but its economic importance now looms ever larger. In this study, the economist and naval analyst Dr. John H. Noer examines the narrow sea passages—or "chokepoints"—in the South China Sea in light of their economic importance to the U.S., its allies, and indeed all major nations.

Drawing upon one of the largest databases of commercial shipping information ever compiled, Dr. Noer at the Center for Naval Analyses portrays in detail the patterns of trade throughout these waterways to show the relative economic dependence of various nations on these maritime routes. To further highlight the economic significance of these "chokepoints," the author assesses the short- and long-term economic impacts of the assumed closure of each of the critical straits in the area—regardless of the reason, whether natural disaster, human accident, blockade, or war. The result is a lucid text, illuminated by detailed tables, graphs, charts, and maps, that make perfectly clear the value of this region to the world economy.

Arising from a U.S. Navy-directed study, this timely and thoughtful analysis is the fruit of a collaboration between the Center for Naval Analyses and the Institute for National Strategic Studies. We are pleased to be able to make such an important book available to the national security community and to the reading public.

Ervin J. Rokke
Lieutenant General, U.S. Air Force
President, National Defense University

Acknowledgments

This study was sponsored by Vice Admiral J. Paul Reason, USN, Deputy Chief of Naval Operations (Plans, Policy, and Operations, N3/N5). Special thanks are due to Rear Admiral Phil Dur, USN (Retired), formerly N51, who as Director of the Strategy and Policy Division provided intellectual inspiration for this work, and made sure that the project was initiated. We are also indebted to Vice Admiral John Mazach, USN, Admiral Dur's successor as N51, who has since moved on to command the Naval Air Force, U.S. Atlantic Fleet. Admiral Mazach took personal interest in the project, and always ensured that the authors received the support they needed.

The project benefited from the cooperation of many; it could not have been done without their help. Thanks are due to many people and institutions, including Bob Murray; Linton Brooks; Jerry Kahan, and our fellow analysts at CNA; the Office of Naval Intelligence, which facilitated data access; Major Tom Krise, USAF, and Dr. Fred Kiley of NDU Press; Captain Walt Thomas, USN (Retired); the Institute for National Strategic Studies; Lieutenant Commander Rick Smith, USN; Lieutenant Newman Evans, USN; the staff of N51; J.C. Owens; as well as Alan, Wally, and Daryl.

Chokepoints:
Maritime Economic Concerns in Southeast Asia

Chapter 1. Overview

To ensure unrestricted sea lines of communication (SLOCs) in Southeast Asia (SEA), the U.S. Navy is assigned the task of helping to maintain clear maritime passage through the sea lanes of the region. For many years, the prime concern was military, not economic, as the United States required secure maritime transport via SLOCs in case of war. Now the emphasis has shifted to the economic component of our national security, a policy reaffirmed when the United States announced it would not accept disruption of trade in the South China Sea. In March and again in May, 1995, Secretary of State Christopher warned quarreling claimants to the Spratly reefs not to interfere with international shipping. What is the *economic* logic behind the American stance on freedom of navigation for commercial shipping? For the U.S. a concern is: "Who benefits from keeping sea lanes open, and how much do they benefit?" A related question is: "Who would be hurt if the sea lanes were closed, and how much would it hurt them?"

Geography and maritime transport

A look at the map of Southeast Asia shows why maritime transport is of special importance to the economies of Asia, specifically transit through the southern South China Sea, the Java Sea, and the Straits of Lombok and Makassar.

Many littoral nations of the South China Sea do not have well-developed land transport infrastructure, such as road and rail, which might otherwise offer substitute modes for maritime transport. For the numerous islands, no such substitute is feasible. The maritime transport mode is more important to this region than it is to most other regional economies. Geography ensures that much of the region's domestic trade and virtually all coastal and intraregional trade moves by sea.

Trade routes and the strategic straits

A large volume of international long-haul maritime traffic crosses this area. Geography also ensures that almost all such trade funnels through the southern Straits of the Indonesian Archipelago, and that the lion's share transits the South China Sea. En route from Africa or Suez to North Asia, large merchant vessels have only a few choices of what course to sail. There are five main options:

- *Malacca Straits.* The Malacca Straits are draft limited to 72 feet. The shipping lanes narrow down to 1.5 miles wide at the east end of the waterway. The depth, while a constraint, allows all but the largest merchant vessels to transit fully laden. It is the shortest route for most traffic, for example, Suez or Arab Gulf to North Asia. Malacca is generally thought to be the second busiest strait in the world, and much more constricted than the busier English Channel. In the 19th century, the British claimed an island by a natural harbor astride the Malacca Straits, which separate Sumatra from the Malay Peninsula. There they founded Singapore, now the main commercial port of the southern South China Sea.

- *Sunda Strait.* Sunda was the old Dutch entrance to the South China Sea, separating the islands of Java and Sumatra. Now, it is little used by international traffic. It remains the most direct route in terms of distance for some routes, for example, from the Cape of Good Hope to North Asia. The Dutch built their base of colonial operations, the port capital called Batavia (now called Jakarta) on Java near the Sunda Strait. The Sunda Strait has a tricky channel, a live volcano, and some draft limitations.

- *The Straits of Lombok and Makassar.* Farther east is the Strait of Lombok, which separates Bali to the west and Lombok to the east. From Lombok, mariners bound north can sail between Kalimantan (Borneo) and Sulawesi (formerly the Celebes) via the Makassar Strait. This is the only major route through the islands that is not draft limited. While little east-west traffic transits Lombok-Makassar, it is an important route for Australian north-south trade. Ships can also pass Lombok to the east.

- *Ombai-Wetar Straits.* East of Lombok, to the north of Timor, are the Straits of Ombai and Wetar. It is possible to pick one's way through deep water northward from Ombai-Wetar, and access routes to North Asia. This route is rarely used by large long-haul merchant vessels on international voyages.

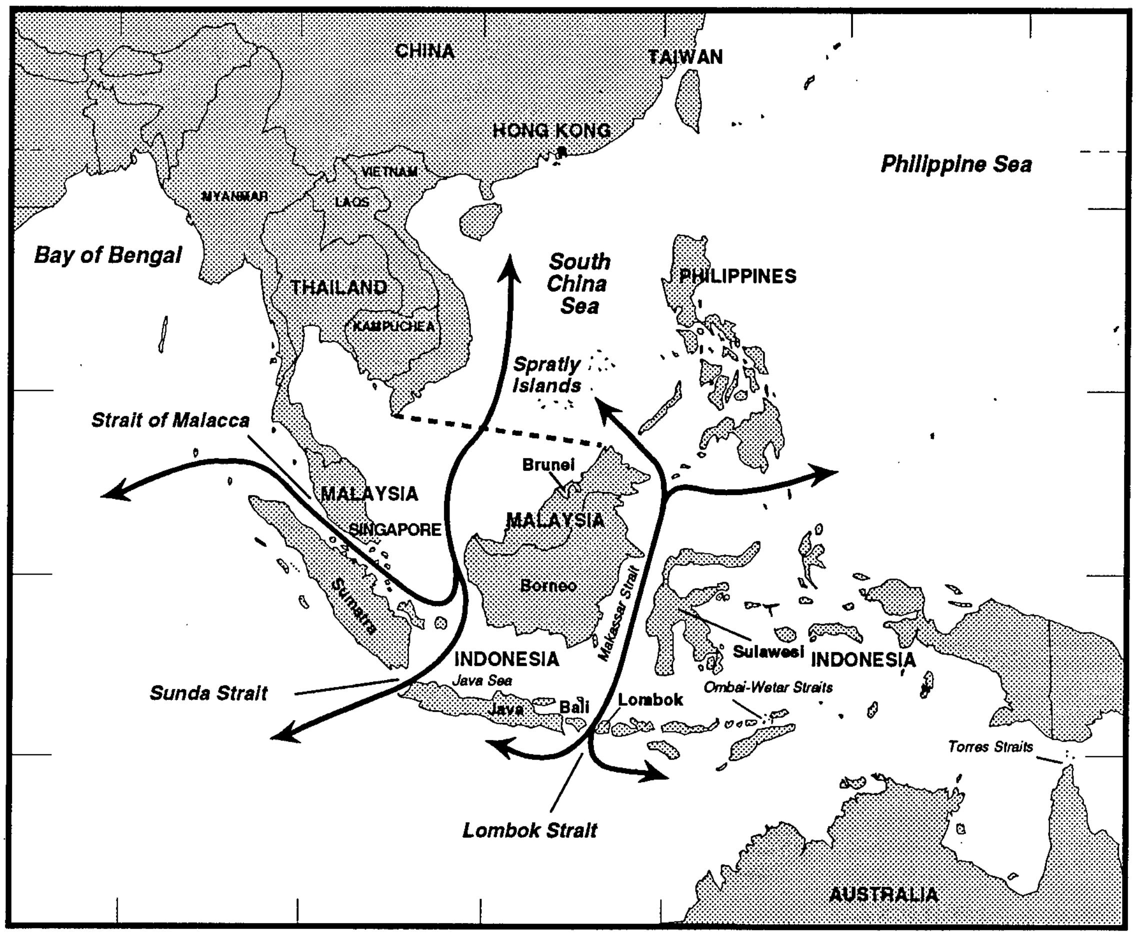
- *Torres Strait.* Farther east lies the Torres Strait between Australia and Papua-New Guinea/Irian Java. Torres waters are draft limited to 12 meters—impassable to large heavily laden merchant men and many blue-water warships.

Toward the east are a few alternative little-used channels, for example, San Bernadino. Ruling out Ombai-Wetar (unmarked, circuitous, and without ports) and Torres (too shallow, with currents) leaves three southern gateways for main shipping routes through the archipelagoes: the Straits of Malacca, Sunda, and Lombok. The other option is to sail along or around Australia. Once in the South China Sea, all ships sailing north must sail past the Spratly Islands.

Merchant shipping in Southeast Asia

In 1993 over half of the world's merchant fleet capacity—more than one-third of the world's ships—sailed through the Straits of Malacca, Sunda, or Lombok, or sailed past the Spratly Islands. This volume of shipping sailing on the South China Sea gives the region its global significance. Shipping traffic through Malacca is several times greater than traffic through either the Suez or Panama canals (figure 1).

Figure 1. Strategic chokepoints: Straits of Malacca, Sunda, and Lombok and SLOCs passing the Spratly Islands



Many nations in Southeast Asia are insular or peninsular, or have extended coastlines, so most trade moves by sea, and merchant shipping thrives on three "southern entrances" into the region: the Straits of Malacca, Sunda, and Lombok. Vessels passing by the Spratly Islands on the South China Sea add significantly to the area's congestion.

Over one-half trillion dollars of long-haul interregional seaborne shipments passed through these key "chokepoints" in 1993. This $568 billion was over 15 percent of *all* the world's cross-border trade, and doesn't include trade within the region. Japan, Australia, and the nations of Southeast Asia send over 40 percent of their trade by sea through these chokepoints, and the Newly Industrialized Economies (NIEs) of Hong Kong, Taiwan, and South Korea send more than one-quarter of their imports and exports through these SLOCs. In consequence, the economic vitality of these nations—and their trading counterparts—clearly depends on free, unrestricted and secure access to these sea lanes.[1]

What if the Southeast Asian SLOCs closed?

At present, events that could disrupt passage through the Southeast Asian sea lanes for an extended period of time are not likely to occur. Nevertheless, circumstances can change, and unanticipated challenges could arise that might cause sustained disruption with serious consequences. Understanding such consequences helps identify and evaluate the benefits of mutual cooperation between the United States and other nations assuring the unimpeded flow of maritime traffic through these waterways.

Obstruction of these shipping lanes might not be a serious matter theoretically. Alternate routes are available. In practice, however, closure of these SLOCs matters a great deal. Nearly half the world fleet would be required to sail farther, increasing demand for vessel capacity. All excess capacity of the world fleet might be absorbed, if ships had to sail farther to deliver their cargoes. The negative impact would be strongest for crude oil shipments and dry bulk, such as iron ore and coal.

Sustained closure of the Straits of Malacca would be for some nations expensive, even disastrous. Denial of free access to the SLOCs passing the Spratly Islands to merchant shipping would disrupt area shipping markets severely. Freight rates around the world also would be affected, adding costs to most imports and exports. The factor that converts a *localized* maritime concern (SLOC closure) to a *global* economic event (freight rate crisis *cum* capacity shortfall) is the large volume of shipping and world trade transiting the South China Sea.

1. See appendix A for details on commodities: "Trade flows through the SLOCs."

Flags and vessel ownership

Most vessels plying the region fly flags of convenience. The most common flag in the region is Panamanian; the second is Liberian. Japanese interests own more ships operating in the region than any other country. Most are "flagged out," so Japanese presence is discreetly understated. U.S. interests are third, behind Japan and Greece, in terms of "capacity-owned" ships passing through the Straits of Malacca in 1993. Over three-quarters of U.S. ships in Southeast Asia flag out.

There is little correlation between nationality of registration and nationality of owners; also, there may be little relationship of flags to the economies shipping or receiving cargoes. The concept of "nationality," as applied to shipping, is ambiguous. Policies that would try to discriminate among shipping on the basis of nationality would be based on a faulty premise. Nationality is not a meaningful concept when applied to merchant shipping, with its chameleon-like quality. So, maritime policies must be internationalist in nature, and not designed to discriminate between vessels on the basis of cargo or national ownership, or flag registration.[2]

Policy implications

The concept of "freedom of navigation" has economic and strategic significance, and the United States has tangible economic interests in maritime stability in the South China Sea. Commercial freedom of navigation is a prerequisite to (but not a guarantee of) global free trade, as well as a national U.S. policy.

World shipping markets link Southeast Asian sea lanes to the U.S. economy, though many are halfway around the world and carry small amounts of U.S. trade. If events threatened trade in the South China Sea, ships could detour, but they would have to travel farther to deliver their cargoes, incurring higher cost and raising demand for global shipping capacity. If access to key Southeast Asian SLOCs is ever denied, freight rates would increase worldwide, at least as a result of long-term blockage of world shipping around there. Shippers on the east and west coasts of the United States could be forced to use alternate routes and pay higher shipping rates, or lose service. These costs might be passed on to U.S. producers and consumers.

Specifically, all trading nations have a vested interest in preserving stability in the Southeast Asian SLOCs. The fact that Southeast Asian SLOC closure hits nearby

2. Maritime trade is further complicated by noting the ship, flag, and cargo may be owned by three *different* "national entities," or consortiums, and the cargo itself may originate and/or be delivered from and to nations unrelated to ownership or flag registry.

countries hardest should also be a stabilizing factor. Countries best able to defend these SLOCs are equally motivated to keep them open. Some nations have much more stake than the United States in free movement of ships on Southeast Asian SLOCs, and these nations should be encouraged to cooperate and share the costs of SLOC protection and safe navigation.

The U.S. Navy will always carry out its traditional mission of protecting freedom of the seas. During the Cold War, protecting *economic* SLOCs was subordinate to protecting *military* SLOCs. As the Cold War mind-set recedes, the naval mission of protecting shipping could emerge as an explicit national priority.

Chapter 2. Trade routes and shipping patterns

Strategic SLOCs

Malacca, Sunda, and Lombok Straits serve as "southern entrances" to the South China Sea. Ships sailing the main routes north on the South China Sea must pass by the Spratly Islands, which for the most part are more reefs than islands. The immediate area is labeled "dangerous ground" on charts, and is nearly always avoided by merchant vessels because of navigational hazards. Most vessels pass to the west, between the reefs and Vietnam, although there is an alternative course to the east near the coast of Palawan of the Philippines. The two northern exits of the South China Sea are the Luzon Strait, separating Taiwan from the Philippines, and the Formosa Straits, separating Taiwan from mainland China.

The database

A database has been established for depicting the actual trade routes and shipping patterns through this geographical region. In principle, some policy questions about national interests are quantitative and can only be answered by processing real-world data. In practice, "chokepoint data" exists in fragments, in dispersed locales, never in one unified database, let alone digested or analyzed.

Processing raw data involves three steps:

- Searching commercial, global vessel movements containing 2.2 million port calls for 1993, looking for pairs of port calls that implied a voyage across four chokepoints, and keeping track of the vessel identified for all its transits. A vessel characteristics file of the world merchant fleet contained data on 26,164 vessels greater than 1,000 deadweight tons (DWT).[3] This was categorized into 36 ship types. For each vessel identified as having entered the study area, ship data such as capacity, type, flag, and nationality of parent company was obtained.

3. The term "deadweight tons" is a measure of the size or capacity of a vessel, and refers to the weight the tanker can carry measured in metric tons.

- "Voyaging" ship data, requires collecting the port call history of identified vessels. The voyages were from port of loading to port of discharge, and return, for bulk carriers. Cellular (container) and general cargo vessels were analyzed by route, and 8,842 vessels passing through Southeast Asia on nearly 94,000 voyages in 1993 were identified. Individual vessel records provided traffic density estimates for the major international shipping routes through the straits. This method of "derived transits" has the advantage of tracing ships from origin to destination and positively identifying individual ships, as well as building vessel counts of traffic through the straits. Visual vessel counts often miss vessels (especially at night), generally fail to identify individual vessels, or do not provide information about origin and destination.[4]
- Finally, a global maritime trade database generated estimates of trade flows through the straits, broken out into 40 commodity types. This process allocated the trade flows to ship types, conceptually loading the cargoes on the vessels. This permitted linking shipping patterns to trade flows.

Shipping and trade patterns are relatively stable, so the fact that data are from 1993 does not detract from the timeliness of these results. Patterns in future years will be similar to those of 1993, except that traffic has grown as international trade has grown.

Merchant shipping in the strategic SLOCs

The straits of the South China Sea are a crossroads for world shipping (table 1). More than half of the world's large merchant shipping capacity, and over one-third of merchant vessels in the world fleet, passed through at least one of the chokepoints in 1993. Large dry bulk carriers were especially prominent, as were supertankers and large cellular (container) vessels. Not only are many of the world's vessels operating in the region, but many are relatively large vessels.

4. Statistics were validated by visiting observation points in the Straits of Malacca, and comparing results to samples of visual counts of passing vessels.

VESSEL TYPES

Table 1. Merchant vessels transiting key SLOCs in Southeast Asia in 1993 (vessels and capacity by type and as *percentage of the world fleet*)

Vessel type	Ships observed in Malacca, Sunda, Lombok, or Spratly SLOCs[a]		Percentage of world fleet	
	Vessels	MDWT[b]	Vessels	Capacity
Large cellular (>2500 TEU[c])	210	10.0	68	68
Small cellular (<2500 TEU)	431	9.0	40	46
General cargo	2,710	33.3	29	43
Large dry bulk	272	42.6	75	77
Other dry bulk	2,301	85.0	52	55
Combo	121	16.6	35	48
Supertankers (>160K DWT)	297	77.8	63	59
Tankers (<160K DWT)	494	32.1	23	34
Product	912	29.1	33	46
Special	1,094	17.5	22	42
Study total, 1993	8,842	353.0	34	51
World fleet, 1993	26,164	689.6	100	100

a. Includes vessels larger than 1,000 DWT on international voyages that have transited the Straits of Malacca, Sunda, or Lombok, or have sailed past the Spratlys on international voyages in 1993. The area includes the Java Sea, the southern and central South China Sea, and the Straits of Lombok and Makassar.

b. MDWT = millions of deadweight tons.

c. TEU = twenty-foot equivalent unit.

Over half of all interregional tonnage passing through Malacca is either coming from or going to the Arab Gulf (table 2). About half of interregional tonnage through Malacca is either coming from or going to Southeast Asia. Over a third of tonnage is going to or coming from Japan, and next in shipping volume are the Newly Industrialized Economies (NIEs) of Hong Kong, Taiwan, and South Korea.

Table 2. Deadweight tonnage (1993) of shipping capacity by *source and destination* region via Malacca (in millions DWT)[a]

Region	Destination tonnage	Source tonnage	Percentage going to/ coming from[b]
Arab Gulf	426.6	395.9	54.5
S.E. Asia	379.0	395.2	51.3
Japan	274.2	283.0	36.9
Asia NIEs[c]	159.5	160.8	21.2
Europe and Med	92.4	108.2	13.3
Indian - SC	77.9	74.8	10.1
Other	99.4	91.1	12.6
China	39.5	32.2	
Africa	36.9	25.9	
Australia	15.5	22.4	
U.S.	5.6	6.1	
S. America	0.8	1.6	
Caribbean	0.5	0.2	
Russia F.E.	0.3	0.3	
Canada	0.2	2.5	
Total	1,509.0	1,509.0	200.0

a. Interregional shipping over 1,000 DWT merchant.
b. Note that the sum of all origins and all destinations will equal twice the traffic volume.
c. Hong Kong, South Korea, and Taiwan.

The pattern is similar by the Spratlys (table 3). Japan jumps to the top of the list, with half of interregional tonnage. Arab Gulf shipping is second, Southeast Asia third, and the NIEs fourth. These four account for most of the tonnage passing by the Spratlys, with China entering the list a distant fifth.

Table 3. Deadweight tonnage (1993) of shipping capacity by *source and destination* region via Spratlys (in millions DWT)[a]

Region	Destination tonnage	Source tonnage	Percentage going to/ coming from[b]
Japan	369.0	364.8	50.6
Arab Gulf	315.7	307.5	42.9
S.E. Asia	305.7	279.5	40.3
Asia NIEs[c]	237.7	257.1	34.1
China	56.6	63.6	8.3
Africa	45.0	56.9	6.1
Europe and Med	46.4	42.8	7.0
Indian - SC	38.4	43.4	5.6
Other	36.8	35.7	5.0
Australia	15.4	1.7	
U.S.	14.3	16.0	
S. America	5.5	15.5	
Russia F.E.	1.1	0.7	
Canada	0.4	1.6	
Caribbean	0.3	0.3	
Total	1,451.3	1,451.3	200.0

a. Interregional shipping over 1,000 DWT merchant.
b. Note that the sum of all origins and all destinations will equal twice the traffic volume.
c. Hong Kong, South Korea, and Taiwan.

In the Straits of Lombok, nearly all interregional shipping is either coming from or going to Australia (table 4). The other end of the voyages through Lombok are Asian: Japan, NIEs, China, or Southeast Asia. Sunda's interregional traffic is tied to Southeast Asia, with Africa as a surprise second (table 5).

LOMBOK TONNAGE

Table 4. Deadweight tonnage (1993) of shipping capacity by *source and destination region* via Lombok (in millions DWT)[a]

Region	Destination tonnage	Source tonnage	Percentage going to/ coming from[b]
Australia	160.4	131.8	98.4
Japan	71.4	87.7	53.6
Asia NIEs[c]	28.1	47.5	25.5
China	20.2	15.2	11.9
S.E. Asia	9.7	12.8	7.6
Other	7.2	2.0	3.1
Arab Gulf	5.4	0.3	
Indian - SC	0.5	0.7	
Europe and Med	0.4	0.6	
Africa	0.3	0.1	
U.S.	0.2	0.2	
Russia F.E.	0.2	0.1	
Canada	0.0	0.1	
Total	297.0	297.0	200.0

a. Interregional shipping over 1,000 DWT merchant.
b. Note that the sum of all origins and all destinations will equal twice the traffic volume.
c. Hong Kong, South Korea, and Taiwan.

SUNDA TONAGE

Table 5. Deadweight tonnage (1993) of shipping capacity by *source and destination region* via Sunda (in millions DWT)[a]

Region	Destination tonnage	Source tonnage	Percentage going to/ coming from[b]
S.E. Asia	41.4	41.2	80.7
Africa	20.8	38.3	57.7
Asia NIEs[c]	18.0	9.6	27.0
Japan	17.9	5.9	23.2
Other	4.3	7.4	11.4
China	2.4	1.5	
Indian - SC	1.0	0.8	
Europe and Med	0.5	2.6	
Arab Gulf	0.5	2.0	
Australia	0.0	0.2	
Canada	0.0	0.1	
Total	102.4	102.4	200.0

a. Interregional shipping over 1,000 DWT merchant.
b. Note that the sum of all origins and all destinations will equal twice the traffic volume.
c. Hong Kong, South Korea, and Taiwan.

Interregional trade patterns

The volume and value of cargo movements by origin and destination, and by commodity type is depicted in figures 2 through 4. Trade flows for selected commodities are in figures 5 through 9.

Figure 2 shows the volume of trade in terms of tonnage through the SLOCs by region of *origin and destination.* Demand for shipping is driven by world trade; the shipping patterns in the previous section reflect these trade movements. Note that the dominant supplier on the Malacca-Spratly route is the Arab Gulf, and via Lombok is Australia. A majority of the cargo moving through all four chokepoints is headed for Japan and the NIEs, or coming from or going to the Southeast Asian states.

Figure 3 restates origins and destinations by cargo value. Europe becomes the major destination by cargo value, while Japan dominates as a point of origin, for cargoes passing the Spratlys and Malacca. A large percentage (by value) of interregional cargoes flowing through the South China Sea past Singapore consists of Japanese exports to Europe.

There is a general pattern of bulk traffic moving east and north across the South China Sea and Indonesian archipelago. This is raw material for the industry of north Asia. The bulk trade tends to be "one way" in nature. Geology determines the sources of supply. Economic factors determine the location of demand.

Finished goods tend to move south and west in return. Finished products mostly move from Japan, South Korea, Taiwan, and Hong Kong south toward Southeast Asia, and on to Europe; however, there is also considerable trade in all directions.

Figure 4 shows commodity flows through the four chokepoints, by tonnage and by cargo value. Tonnage via Malacca and the Spratlys is dominated by liquid bulk (crude oil), with dry bulk (coal and iron ore) second. The smaller tonnage flowing through Sunda and Lombok is dominated by dry bulk. When we look at cargo value instead, finished products dominate, such as autos, machinery, and industrial and consumer products.

Figure 5 is a map of interregional maritime crude oil shipments across Southeast Asia in 1993. Most came from the Arab Gulf and went to Japan, with Southeast Asia as the secondary source and the Newly Industrialized Economies as the number two destination. Figure 6 is a map of supertanker movements. Not surprisingly, they correlate closely with figure 5. Figure 7 is a map of small tanker movements, which exhibit a different pattern. Small tankers ply the minor routes.

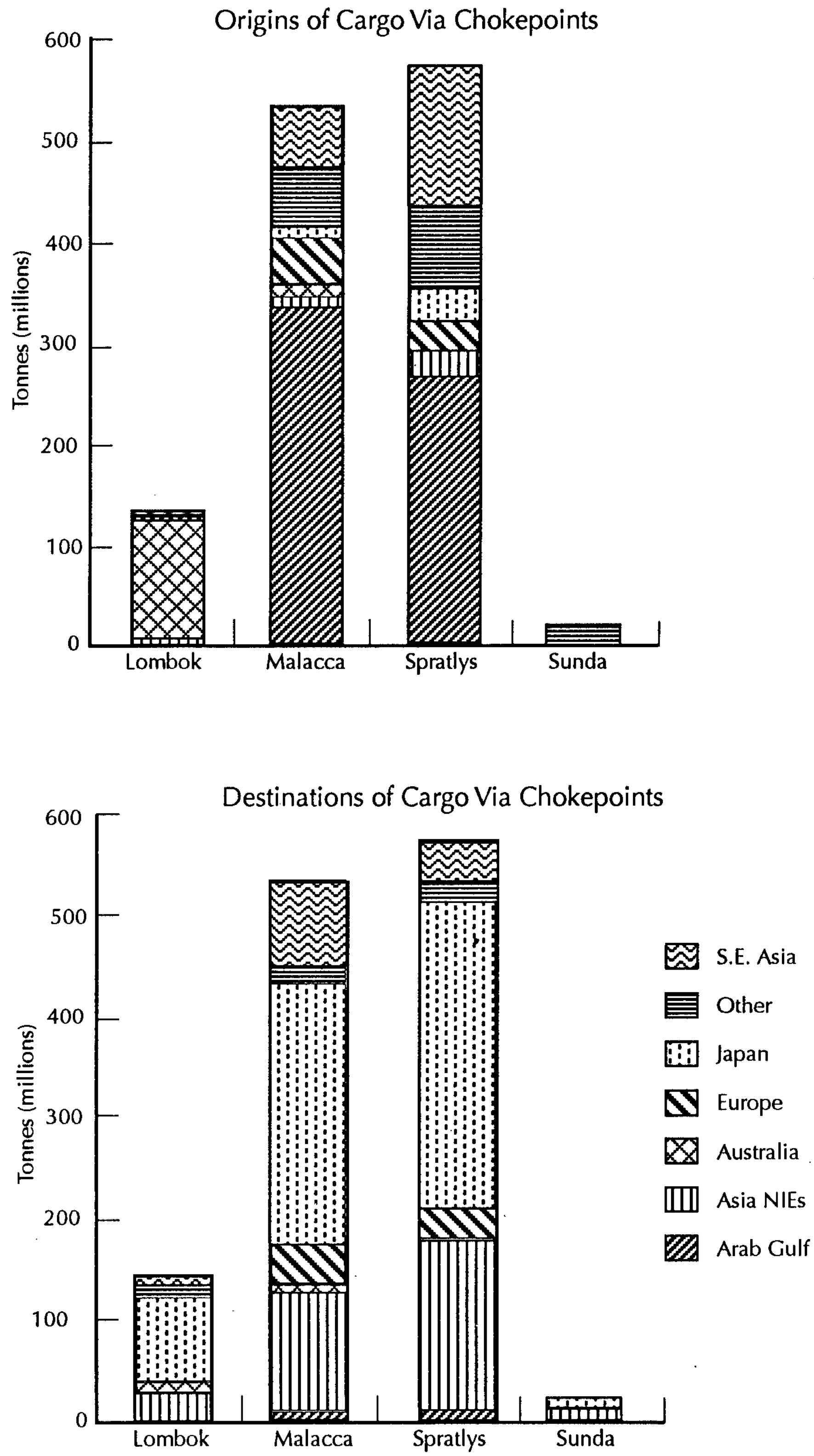
Figure 8 shows a map of interregional coke and coal movements across Southeast Asia in 1993. Australia is the main source, while South Africa is the second largest source. The main destinations are Japan and the NIEs.

Figure 9 shows a map of iron ore movements. They also are dominated by south-to-north flows from Australia to north Asia. India contributes significant shipments, and cargoes arrive across the Indian Ocean from diverse sources.[5]

5. For additional detail on trade flow in the study region, see appendix A: "Trade flows through the SLOCs."

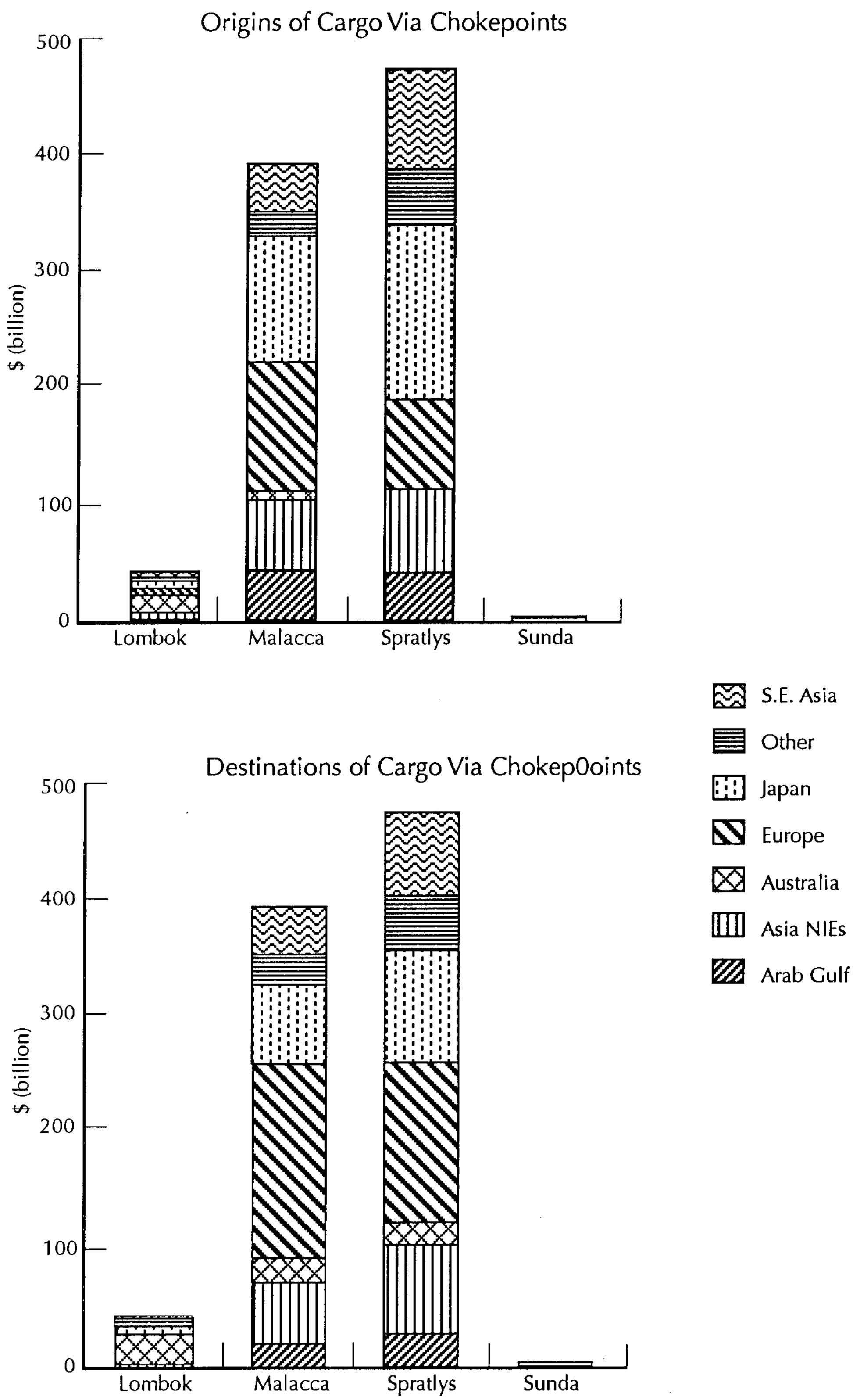
TRADE VOLUME

Figure 2. Volume of interregional trade by region in Southeast Asian SLOCs (1993, metric tons)



TRADE VALUE

Figure 3. Value of interregional trade by region in Southeast Asian SLOCs (1993, U.S. dollars)



COMMODITY: VOLUME/VALUE

Figure 4. Commodity flows in Southeast Asian SLOCs by tonnage and cargo value

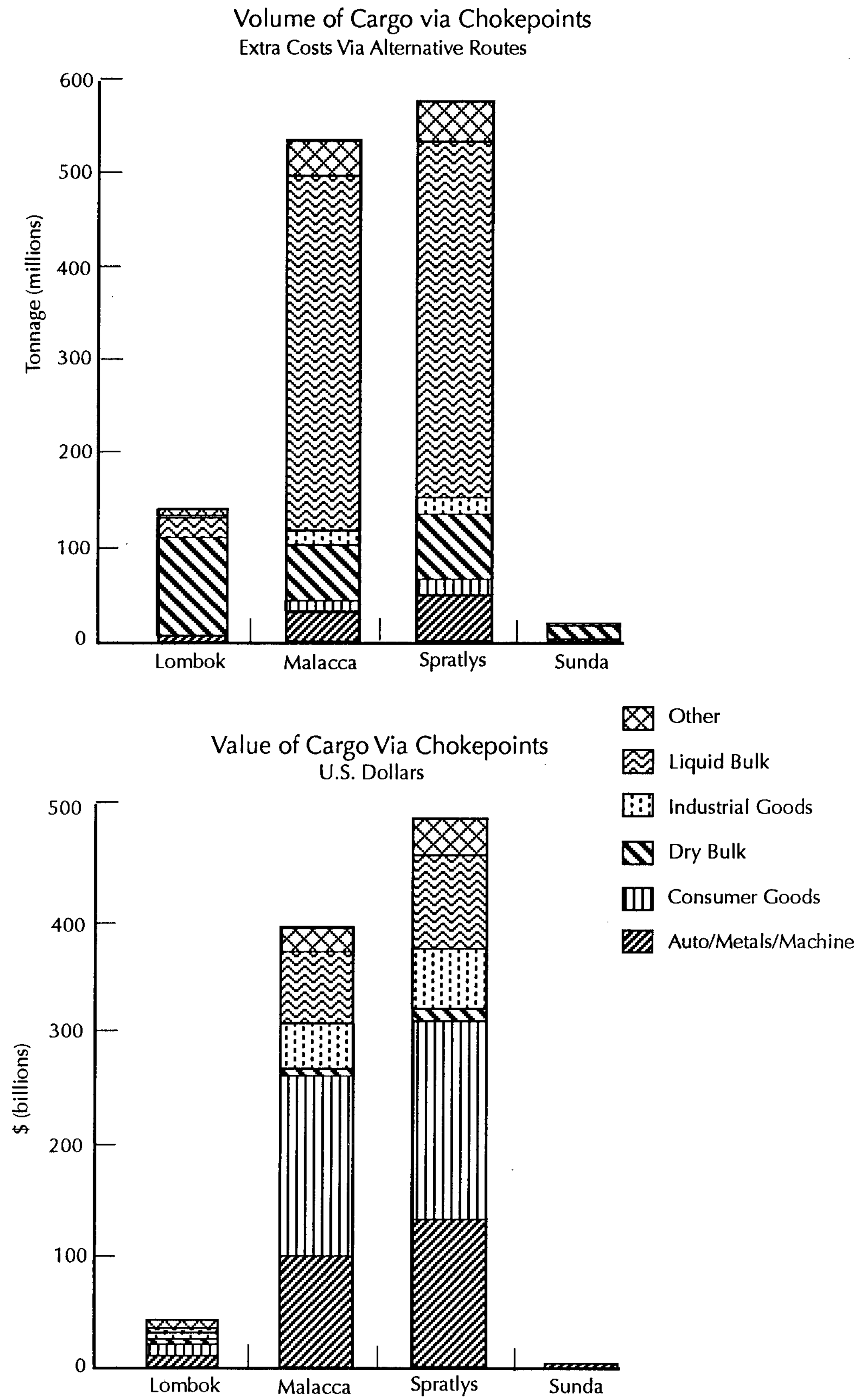


Figure 5. Interregional maritime crude oil shipments: Millions of Long Tonnes (MLT)

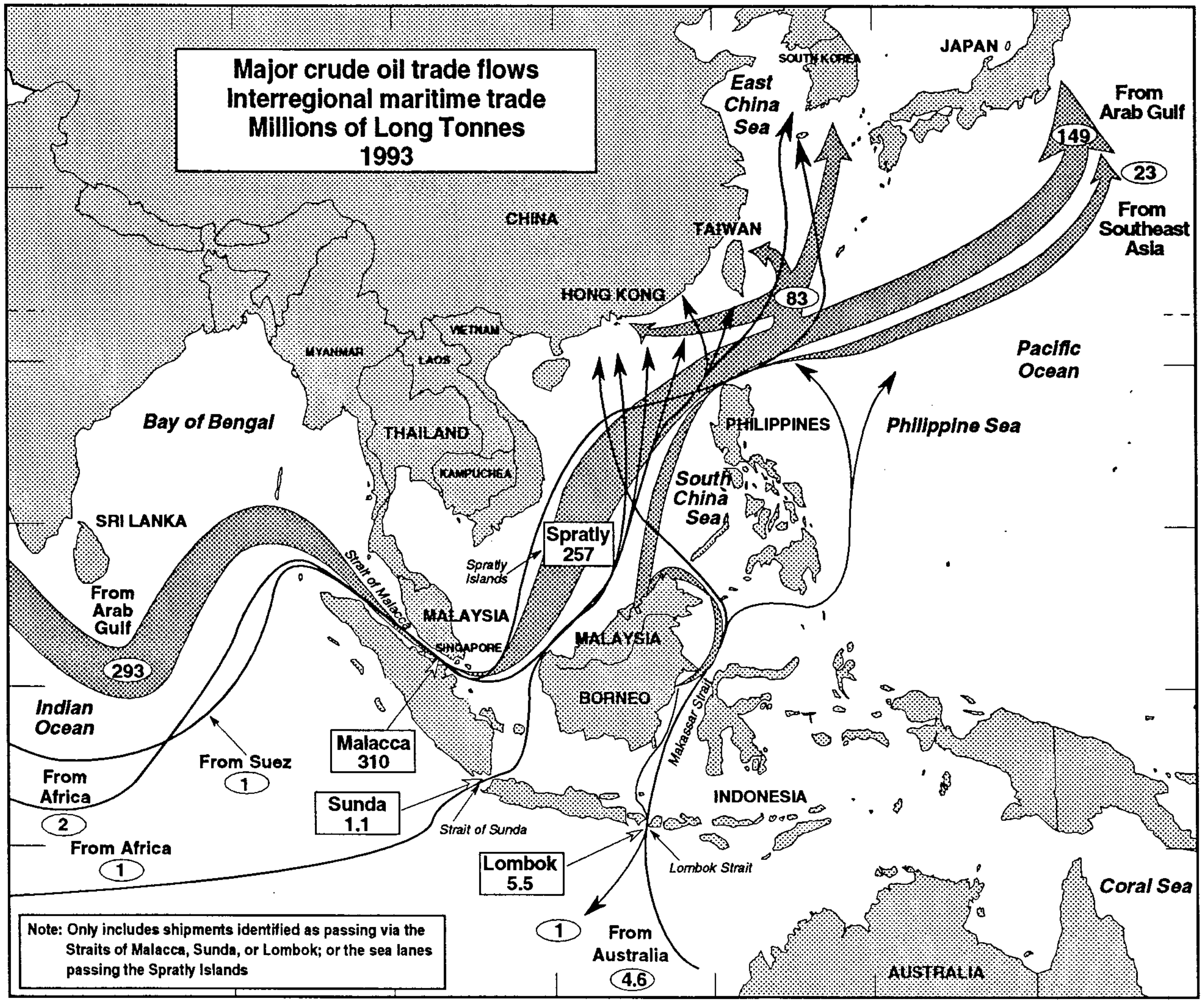


Figure 6. Supertanker movements: Millions of Dead Weight Tonnes (MDWT)

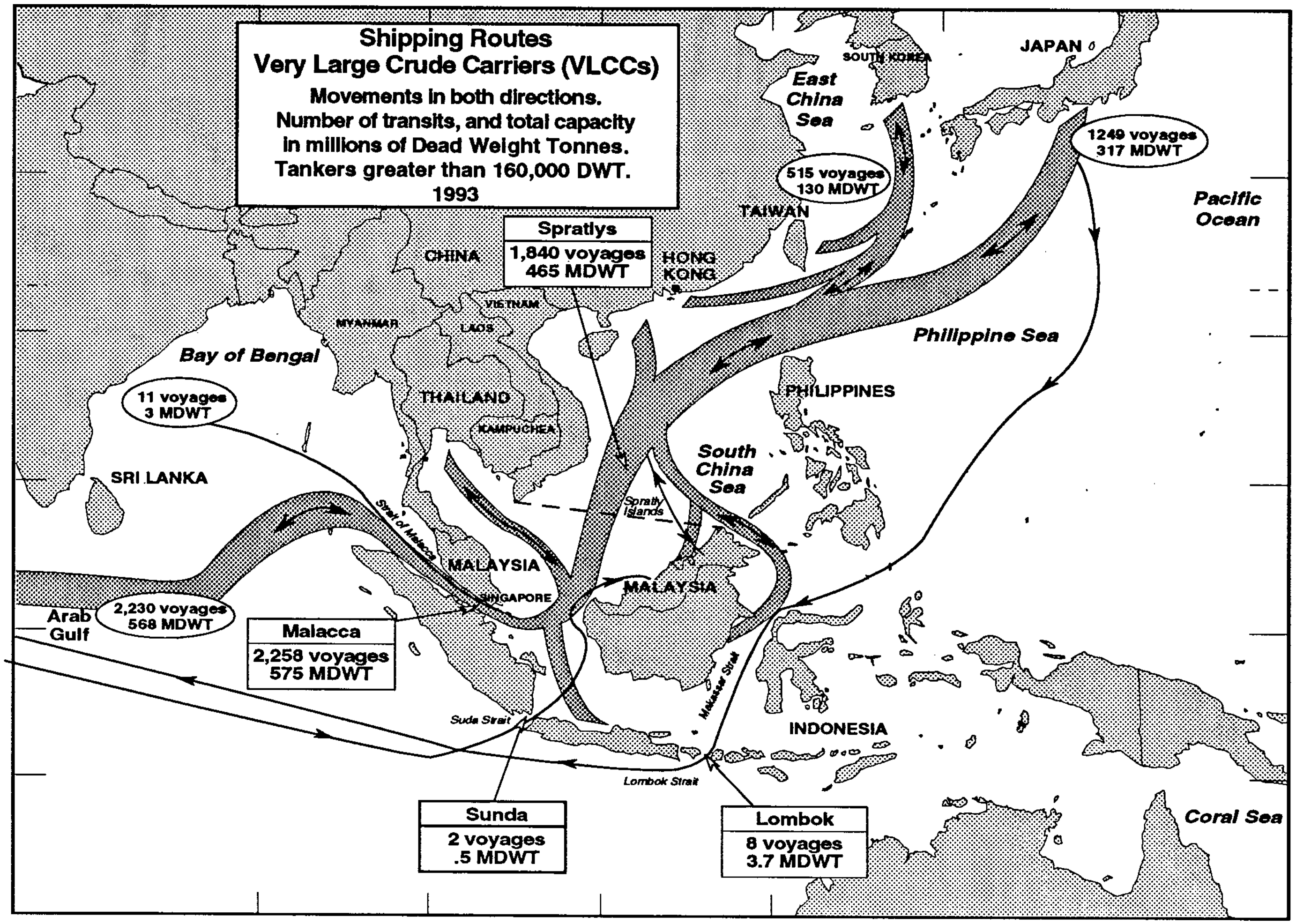


Figure 7. Small tanker movements: Millions of Deadweight Tonnes (MDWT)

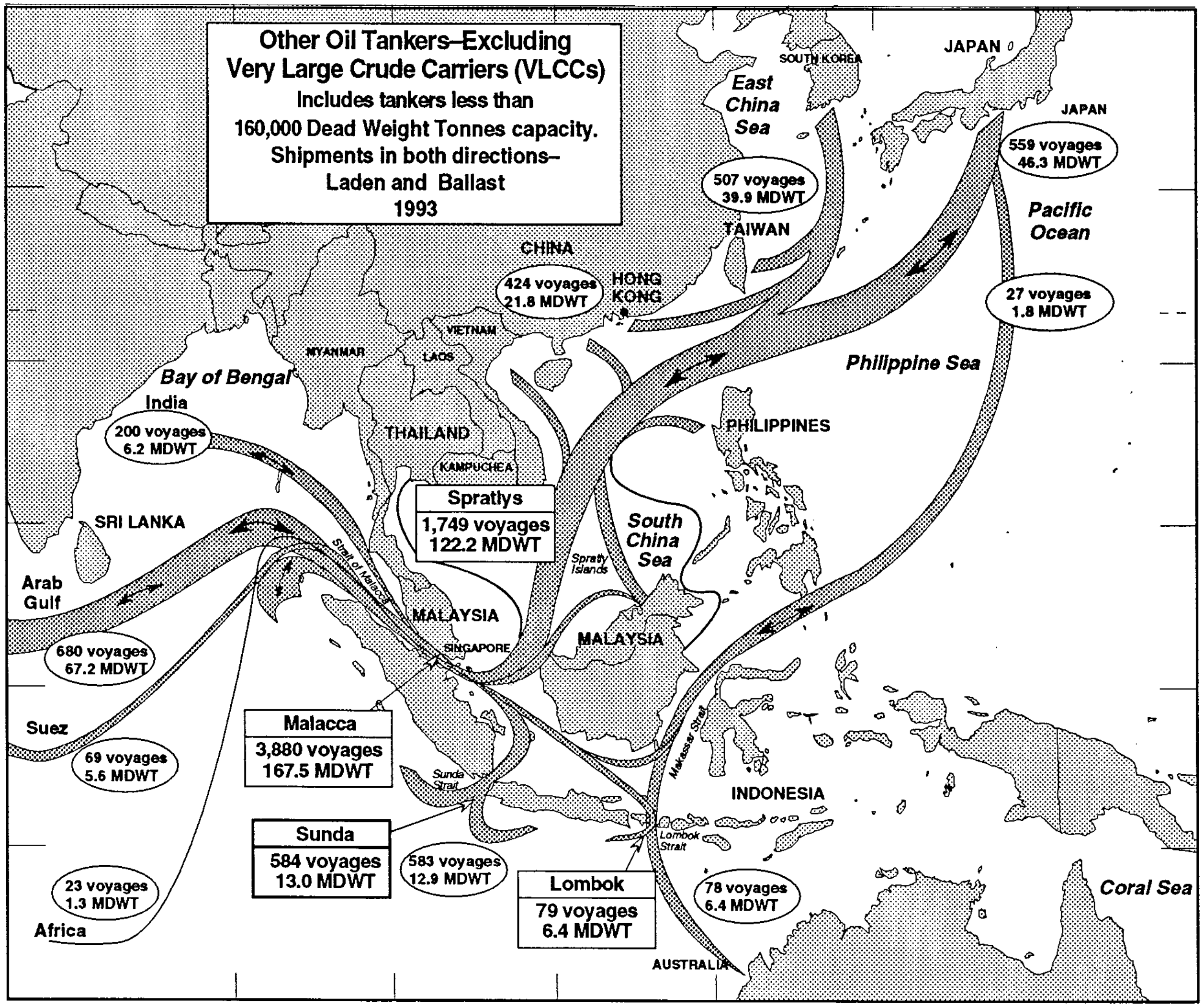


Figure 8. Interregional coke and coal movements: Millions of Long Tonnes (MLT)

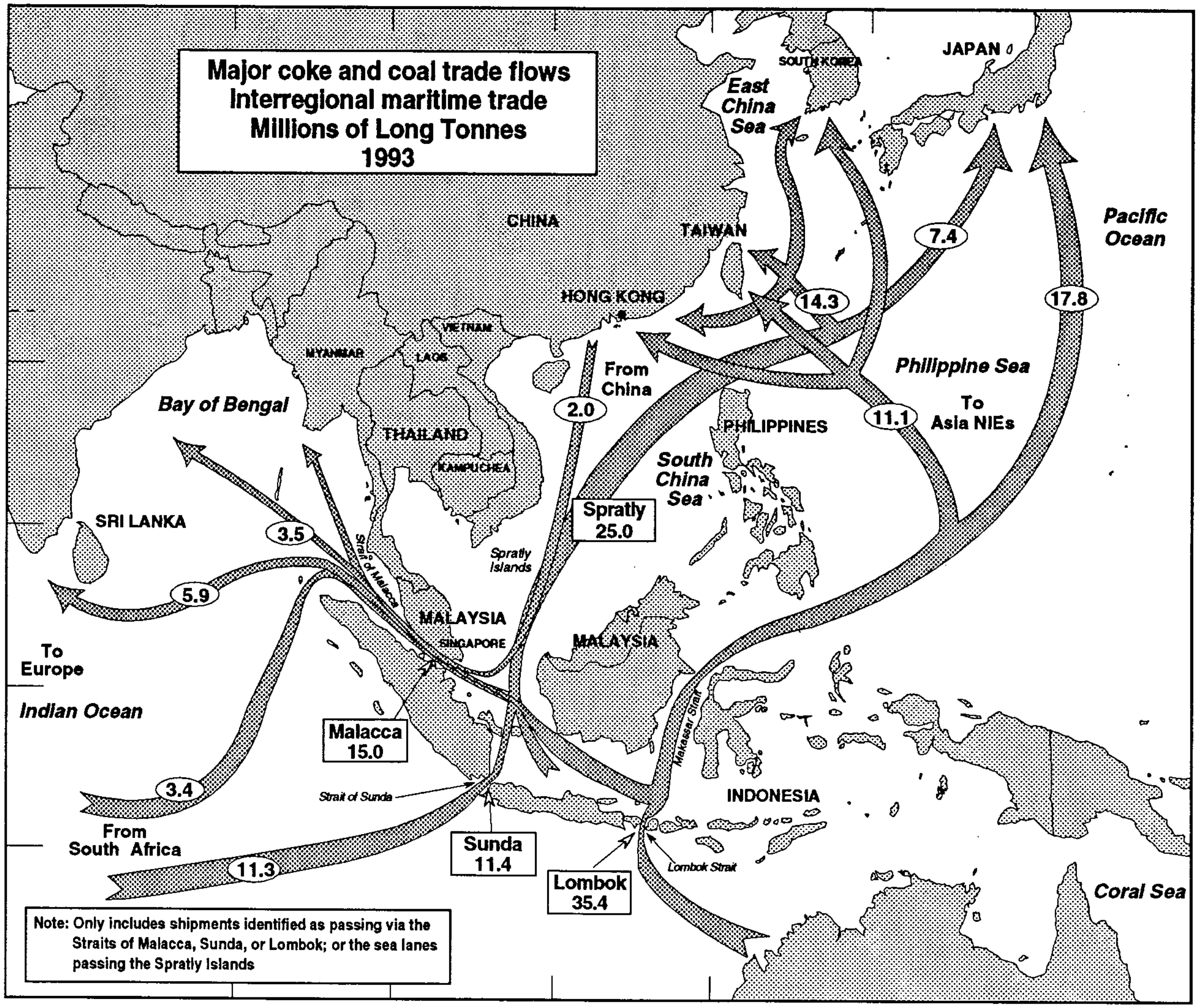
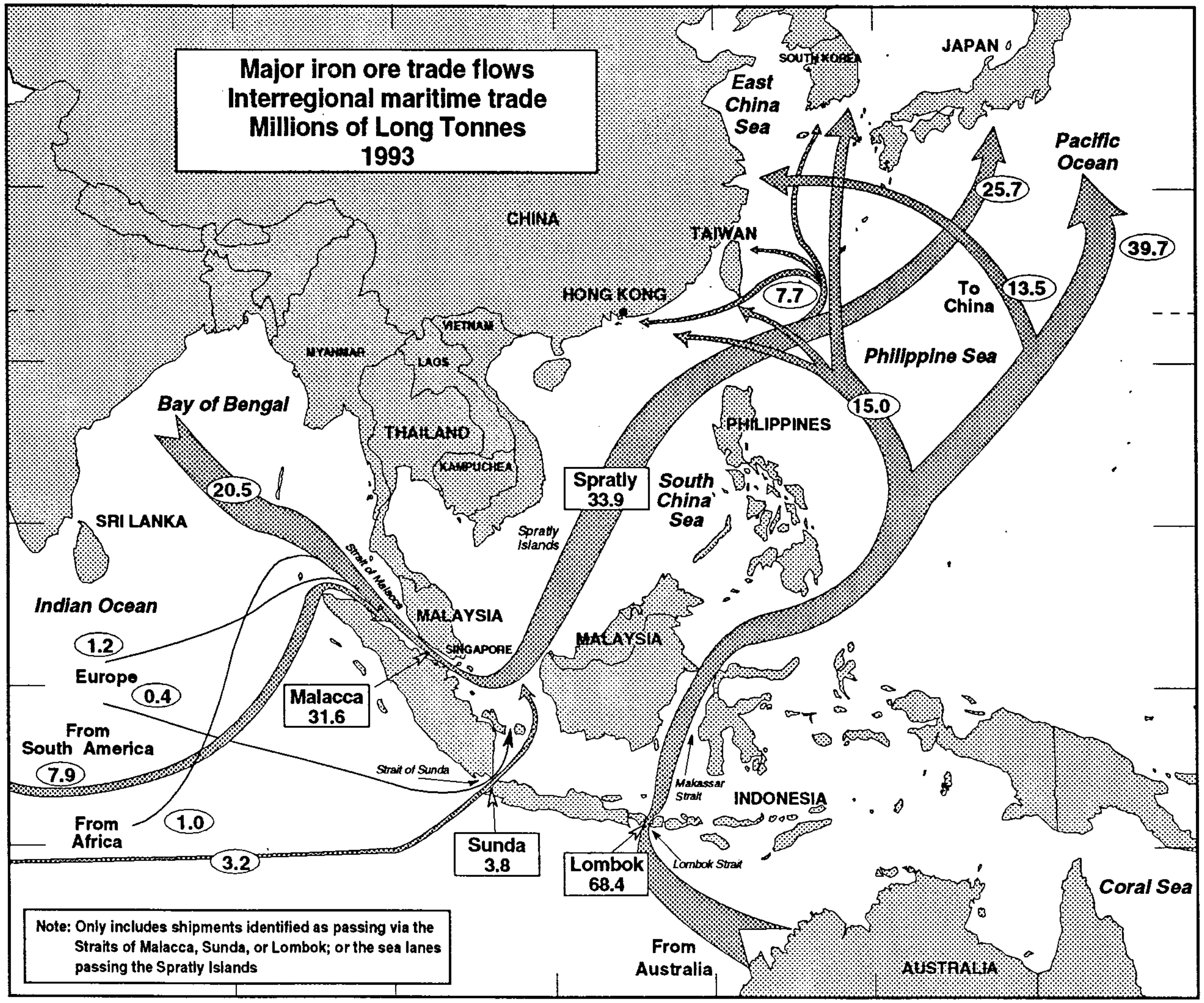


Figure 9. Interregional iron ore movements: Millions of Long Tonnes (MLT)



Economic dependency and strategic chokepoints

How important is a maritime trade route to an economy? One simple measure is the amount and value of a nation's trade passing through a given SLOC. These are, after all, cargoes theoretically at risk. Another measure is the percentage of a country's imports and exports passing through the SLOCs.

Tables 6 and 7 show maritime exports and imports via the key Southeast Asian SLOCs for selected economies. Over 15 percent of all the world's cross-border trade passes through this region. The importance of these waterways to regional trade is clear. Much of their trade comes in or goes out through the Southeast Asian SLOCs.

<u>AREA EXPORTS</u>

Table 6. Maritime exports in the Southeast Asian SLOCs, 1993 (interregional cargoes that passed through the Straits of Malacca, Sunda, or Lombok, or by the Spratly Islands)

Economy	Tons[a] (millions)	Value ($ billions)	Percentage of export value
Japan	33.6	153	42.4
NIEs[b]	24.7	78	25.7
Australia	133.6	17	39.5
China	8.9	20	21.8
Europe[c]	40.8	107	6.8
Southeast Asia	171.2	114	55.4
United States	11.1	15	3.3
World	830.0	568	15.1

a. All tons are metric tons, also called "long tons."
b. Newly Industrialized Economies = South Korea, Taiwan, and Hong Kong.
c. Excludes eastern Europe and other Mediterranean regions.

AREA IMPORTS

Table 7. Maritime imports in the Southeast Asian SLOCs, 1993 (interregional cargoes via Malacca, Sunda, Lombok, or Spratlys)

Economy	Tons[a] (millions)	Value ($ billions)	Percentage of import value
Japan	385.0	102	42.0
NIEs[b]	199.8	85	28.3
Australia	10.2	24	52.8
China	23.0	11	10.3
Europe[c]	41.7	162	10.5
Southeast Asia	139.4	118	52.5
United States	9.5	27	4.5
World	830.0	568	15.2

a. All tons are metric tons, also called "long tons," (also Long Tonnes).
b. Newly Industrialized Economies = South Korea, Taiwan, and Hong Kong.
c. Excludes eastern Europe and other Mediterranean regions.

Japan's maritime trade balance through the area is positive, with the value of exports exceeding imports. For Japan, over 40 percent of both imports and exports flow through the SLOCs. Japan's economy is most dependent on these SLOCs. Protection of the main Malacca-Spratlys route and the Lombok-Makassar alternative clearly is a strategic priority for Japan.

For South Korea, Hong Kong, and Taiwan, as a group (NIEs), about one-quarter of both imports and exports transit the study region. The NIEs are less dependent than the Japanese on the Southeast Asian SLOCs, but would suffer considerably if their SLOC trade was disrupted.

The amount and percentage of Australian trade passing through the study SLOCs may be somewhat overstated, as some New Zealand cargoes may be included. Unlike the North Asian industrialized economies, Lombok-Makassar is by far the preferred Australian route through the region. Australia appears to be the nation that, apart from Indonesia, has a special strategic and economic interest in the Straits of Lombok and Makassar. Australia's other main link is Lombok-Malacca.

For China, three-quarters of the volume of maritime imports through the region is from Australia via Lombok, but this product is of low value, mainly Australian iron ore. It appears that at least one-fifth of exports and one-tenth of imports flow directly to and from Chinese ports through the region. At first glance, that would seem to be enough to account for the Chinese willingness to pursue national interests in the Spratlys and the South China Sea.

Yet, table 6 and 7 numbers underestimate China's real maritime economic interests in the SLOCs. There are unrecorded ship movements and trade; data from Chinese ports are much less complete than data from Japan, for example. Much of China's trade is with Southeast Asia, an area where much traffic is not recorded, so "mirror statistics" do not fill the gaps. There is, for example, lightering of oil offshore bound for Chinese ports that is not captured in the data. Additionally, much of China's trade with Hong Kong is transshipped via the study area, classified as NIE trade rather than Chinese trade. About 70 percent of the container trade via Hong Kong is going to or coming from China. All that having been said, 80 percent of Chinese exports and 90 percent of imports appear to go by other routes. When China acquires sovereignty over Hong Kong, and the two entities are combined in a formal as well as a de facto sense, China's trade patterns will become clearer.

In contrast, for the United States, only 3.3 percent of exports and 4.5 percent of exports transit this region by sea. This is principally trade passing the Spratlys, to and from Southeast Asia. These are significant numbers, given the geography, since the South China Sea is literally half way around the world from the continental United States, nine to twelve time zones away. The United States does quite a bit of trade with the Asian Pacific region, but the physical trade link is typically straight across the Pacific to the U.S. west coast. Trade originating from or arriving at ports west of the South China Sea travels across the Indian Ocean and the Atlantic to the United States. There are very few American trading partners for whom the distance-minimizing or cost-minimizing trade route happens to pass through a Southeast Asian SLOC.

The fact that a fairly small amount of American trade passes through the South China Sea SLOCs does not mean that these trade routes are unimportant to the United States. U.S. prosperity depends on both the prosperity of trading partners and a well functioning world economy. It just means that U.S. economic interests in these SLOCs are for the most part indirect, for reasons of geography. By and large, the United States would feel the pain of a trade disruption more through its impact on U.S. trade partners.

Gross Domestic Product

Gross Domestic Product (GDP) is economic output taking place within a nation. It is the main component in determining national income, which determines expenditures. Table 8 shows exports and imports (i.e., total trade) via the Southeast Asian SLOCs as a percentage of GDP. By these measures, the small industrialized trading economies of the NIEs are the most dependent on the Southeast Asian SLOCs. Exports plus imports combined are over 21 percent of NIE GDP. Japan and Australia also are highly dependent, with imports plus exports via Southeast Asian SLOCs of 10 percent and 12 percent, respectively. The United States has little direct dependence, by this measure at least.

GDP VALUES

Table 8. Imports and exports via Southeast Asian SLOCs[a] as a percentage of GDP

Economy	GDP in 1993 ($ billions)	Exports via Southeast Asian SLOCs as % GDP	Imports via Southeast Asian SLOCs as % GDP
Australia	340	5.0	7.1
China[b]	2,610	0.8	0.4
Japan	2,549	6.0	4.0
NIEs[c]	767	10.1	11.1
United States	6,379	0.2	0.4

a. Southeast Asian SLOCs: Straits of Malacca, Sunda, and Lombok plus the sea lanes passing the Spratly Islands.

b. China's percentages greatly underestimate its dependence on Southeast Asian SLOCs.

c. NIEs = Hong Kong, Taiwan, and South Korea.

Japan, Australia, and the NIEs are especially dependent economically on the Southeast Asian SLOCs. The closer an economy is to a SLOC, the greater its vested interest in free commercial navigation via the SLOC.[6]

Supertankers in the Straits of Malacca

In 1993, 1,121 eastbound supertankers with a capacity of 284.5 million tons carried 271.2 million tons of crude oil through the straits. At least three VLCCs per day passed through Malacca fully laden, many clearing the bottom by little more than 1 meter. Most were going to Japan or north Asia. However, nearly 22 percent of the cargoes were going to Singapore, a center of refining for Southeast Asia.

The Straits of Malacca are shallow, narrow, and congested. There is no organized coordination of shipping movements in the international waterways. As a result, collisions and groundings occur periodically. The governments of Malaysia and Indonesia prefer that laden supertankers use the deeper Straits of Lombok and Makassar to the east as spills of crude oil damage the environment, and large tankers are difficult to maneuver in crowded channels.

Very few supertankers in the region use the Straits of Lombok and Makassar; most use the Straits of Malacca (table 9). Very Large Crude Carriers (VLCCs) typically draw 19 to 22 meters when laden. The depth of the channel in the Straits of Malacca ranges

6. For more detail on economic dependence, see appendix A: "Trade dependence on the strategic SLOCs."

from 21.1 to 22.9 meters, depending on the season. So, if laden, most VLCCs are unable to honor the 3.5-meter clearance preferred by the safety-oriented Malaysian and Indonesian governments. They barely honor a 1-meter clearance, the shipping industry's operational minimum.

<u>VLCC DATA</u>

Table 9. Supertankers in the Straits of Malacca, 1993

	VLCC size (DWT)	
	160–250K	> 250K
Average draft (m)	19.4	21.2
Draft standard deviation	1.0	1.4
Depth in Malacca Straits (m)	21.1 to 22.9	
Desired keel clearance (m)	1.0 to 3.5	
Transits eastbound-laden VLCCs		
Supertankers passing (no. of ships)	452	669
Deadweight tons (MDWT capacity)	105.6	179.8
Crude oil cargoes eastbound		
Millions of tons	102.6	168.6
Value ($ billions)	13.6	21.7
Distribution by trade route (%)		
Arab Gulf to Japan	24.8	30.0
Arab Gulf to NIEs[a]	8.0	14.9
Arab Gulf to Singapore	4.8	17.0
Other oil by VLCC	0.3	0.3

a. NIE = Hong Kong, Taiwan, and South Korea.

Vessel traffic system

Such deeply laden vessels are unable to deviate from the channel to avoid other traffic, heightening the complications caused by congestion. Singapore runs a Vessel Traffic System (VTS) within the Port of Singapore jurisdiction, but no one has legal jurisdiction over traffic in the Straits of Malacca, which remains an international waterway. Malaysia, in early 1995, proposed a VTS for the straits, which would provide radar surveillance together with radio traffic advisories to vessels. Such a system already exists in the English Channel.

Because ships must report in and identify themselves, it is possible that a VTS could be used to control and regulate shipping in the straits and clearly contribute to safety.

The debate between advocates of safety versus proponents of uncontrolled freedom of navigation on high seas may heat up in the future.[7]

Ship ownership and flag of registry

Table 10 lists countries owning the most tonnage passing through the Straits of Malacca in 1993, and the percentage of that tonnage flying another flag, "flagged out" under a "flag of convenience." All the so-called top five nations by ownership flag out half or more of their shipping. Table 11 shows the most common flags observed in Malacca. Three are purely flags of convenience: Panama, Liberia, and the Bahamas. Non-Singaporean interests own slightly over half of the shipping traffic flying the Singapore flag. On this list, only the Japanese flag is reserved primarily for Japanese owners. Which flag a ship flies is a decision of the owner, and provides little indication of the nationality of interests owning the ship.

OWNERSHIP

Table 10. "Top five" *owners* in Malacca (by capacity)

Parent country	Capacity (MDWT)	Capacity of fleet flagged out (percentage)
Japan	432	62
Greece	102	67
United States	97	77
Great Britain	90	91
Singapore	88	50

FLAGS OF REGISTRY

Table 11. "Top five" *flags* in Malacca (by capacity)

Vessel registry	Capacity (MDWT)	Capacity foreign owned (percentage)
Panama	351	100
Liberia	228	100
Japan	176	7
Singapore	101	56
Bahamas	84	100

7. For a more detailed discussion of these issues, see appendix B: "Maritime safety versus freedom of navigation."

Figure 10 shows the distribution of flags flown by Japanese-owned tonnage passing through Malacca. Thirty-eight percent fly the Japanese flag; the rest, foreign flags. Figure 11 shows the distribution of tonnage owned by Panamanian flag shipping in Malacca. Slightly over half are Japanese owned; over three-quarters are Asian owned.

Figure 10. Flags flown by Japanese-owned vessels (by capacity)

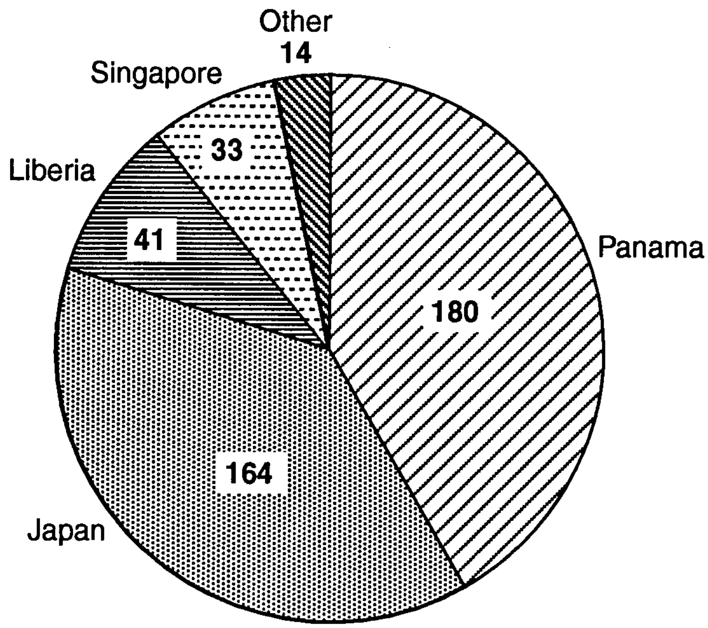
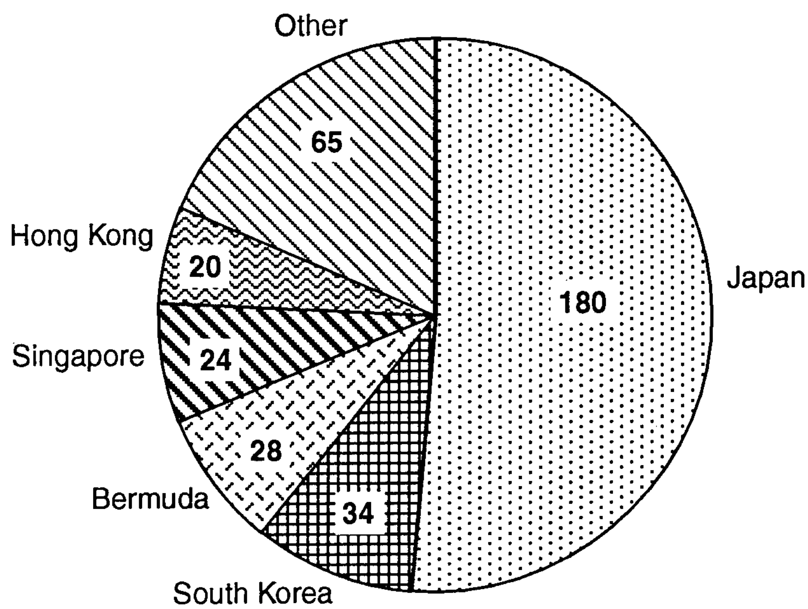


Figure 11. Owners of Panamanian flagged shipping (by capacity)



The third largest owner of Panamanian "flagged" tonnage in Malacca is "Bermudian owned." Bermuda is itself a haven, a base of *registration* for multinational corporations that are not (by and large) owned by the 55,000 residents of Bermuda. Many corporations based in Singapore and Hong Kong are, in turn, owned by foreigners. In short, even *apparent* nationality of ownership is a matter of choice by essentially anonymous owners. In practice, only a few national flags are reserved for ships owned by citizens, such as Japan, the United States, and the People's Republic of China.[8]

8. For more detail on ship ownership, vessel types in the SLOCs and vessel registry, see appendix A.

Chapter 3. What if Southeast Asian SLOCs close?

Could the SLOCs close?

Wars, like volcanoes and other disasters, are low-probability events of high social cost. At present, it seems unlikely that the nations of the region will permit these trade routes to be closed. There are, however, security concerns in the region that might affect freedom of navigation on the SLOCs. Regional history and current events indicate sea lane disruption is possible.

Whatever assumptions are made about the likelihood of serious trade disruptions, analyzing the implications of such posited events graphically demonstrates the dependencies of various trading nations on commercial passage through these vital waterways.

The dispute over the Spratly Islands

Several nations claim part or all of the Spratly Islands and, by extension, claim rights over the waters adjacent to the islands. Five countries maintain armed garrisons on the atolls: mainland China, Taiwan, Malaysia, the Philippines, and Vietnam. The attractions are fish and petroleum, and the islets are the basis for claiming sovereignty over adjacent waters.

In the 1980s, China began occupying islets, and has resurrected a claim to virtually all the South China Sea other than the coastal waters of other states. China and Vietnam have battled over the Spratly Islands on several occasions in recent years. In 1988, Chinese forces sank three Vietnamese vessels and killed about eighty Vietnamese while seizing several of the islands from Vietnam. In 1995, China occupied the Mischief Reef, claimed by the Philippines. The Philippine military subsequently destroyed Chinese structures on the reefs, after which Chinese naval vessels appeared on the scene. Both sides avoided military conflict, but the confrontation aroused consternation throughout Southeast Asia. Conflict over the Spratlys could spill over into the north-south sea lanes of the South China Sea, particularly if China and Vietnam were the protagonists.

Tensions in the South China Sea

In 1974, with the U.S. military gone from South Vietnam, China invaded and seized the western section of the Paracel Island group from South Vietnam. The Paracels are to the north of the Spratlys, near Vietnam. In 1979, China attacked and occupied for several months the border provinces of Vietnam. After China withdrew, tensions along the border remained high for nearly a decade.

The last time Indonesia changed presidents, in 1965, fierce internal turmoil resulted in the loss of many lives. The current president is aging, and Indonesia's domestic situation may be even more complex than it was in the 1960s. Separatist rebellions simmer on some islands, such as Timor, Acheh in Sumatra, and Irian Java.

There also have been tensions among the three nations sharing the shoreline of the Straits of Malacca. In the 1960s, Malaysia and Indonesia quietly fought a war over Borneo; Singapore finds it appropriate to maintain a capable military force.

Other possibilities

Other threats to freedom of navigation include attempts to impose policy restrictions on shipping. There have been proposals to regulate traffic and impose tolls on shipping in the Straits of Malacca. Oil spills associated with accidents in Malacca have hampered shipping in the straits at times, stimulating international calls for regulation of shipping in the name of environmentalism and maritime safety. Additionally, Indonesia seeks to assert control of shipping among its islands under a policy of "archipelagic sea lanes."

Nature can also intervene. Krakatoa, an active volcano, occasionally erupts in the Sunda Straits between Sumatra and Java. Krakatoa has formed new islands in the channel, and has obstructed areas of the Sunda Straits at times in recent years.

At present, however, regional conflicts or sovereignty claims that could disrupt passage through the Southeast Asian sea lanes are not likely to occur. If they did, they would probably not block maritime shipping for an extended period of time. This is so partly because of the naval commitment of the United States and other nations to stability in the region. Nevertheless, circumstances can change, and unanticipated challenges or territorial claims could arise that might cause sustained disruption with serious consequences. Understanding such consequences helps identify and evaluate the potential problems and benefits of military presence and cooperation in Southeast Asia.[9]

9. See Henry J. Kenny, *An Analysis of Possible Threats to Shipping in Key Southeast Asian Sea Lanes,* February 1996 (CNA Occasional Paper 20).

Vessel detours: A danger signal

It is not necessary to barricade the SLOCs physically or militarily to achieve the effects of "closure." If a threat to shipping appears that is deemed credible, merchant vessels are likely to use other routes. A typical mechanism is the maritime insurance markets. If an area is determined to be a war zone, insurers will either refuse to insure or will increase the rates of their policies. Vessel operators may even face the prospect of paying for any and all damage to their vessels, whatever the cause, and shippers similarly may find their cargoes at risk. Alternately, they may face an exorbitant premium for voyages through an area. Such financial risks and penalties may render a SLOC transit unattractive. Such events may lead to "virtual closure," where apprehension alone causes shipping to divert though no vessels are actually being damaged or intercepted.

Detour costs due to longer voyages may not be the only concern should SLOCs on the high seas close. Any event that causes traffic to divert from the most cost-efficient routing must be interpreted as a signal that shipping interests are worried. Ship operators deviate from their normal courses to avoid danger and the loss of cargoes, vessels, and even human lives. If vessels reroute, the fact that detours are occurring is a signal that the shipping industry may fear even greater losses. So, even if detour costs per se are not significant, policy-makers should take SLOC detours seriously.

Evaluating SLOC closure

Professor Robert Fogel of the University of Chicago, a recent winner of the Nobel Prize in economics, is the most eminent practitioner of the counterfactual strategy of analysis. This technique permits the use of all available data from diverse sources, and provides a realistic framework. The idea is to start with the real world both as a conceptual model and as a data source.[10] This strategy is used in analyzing the trade flows and ship movements in the following scenarios.

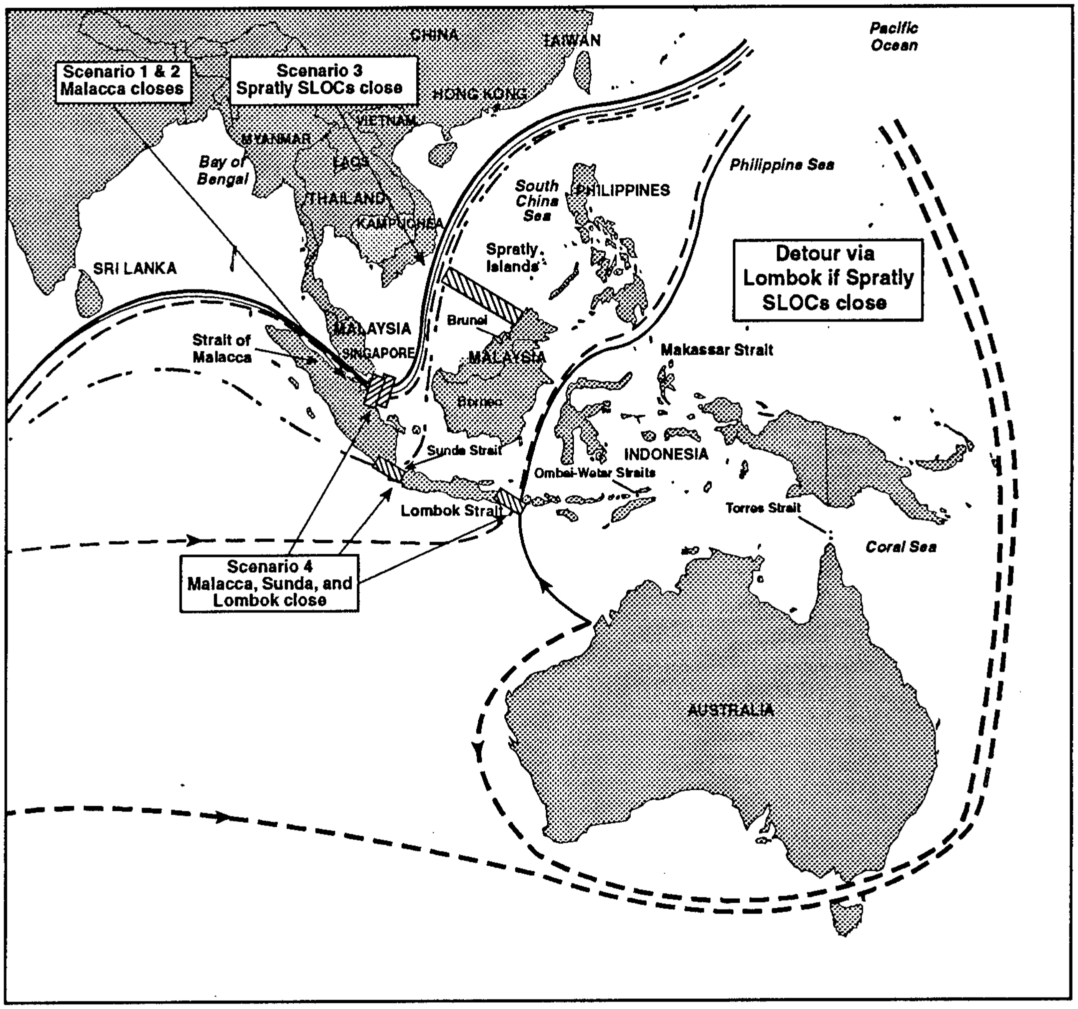
The scenarios

These scenarios are constructed with geography in mind, and in line with a nonpredictive approach to world events. However, they do shed light on the economic ramifications of regional security concerns. The scenarios range from bad to worse to disastrous, for vessels on the main transport artery via the Straits of Malacca and the South China Sea (figure 12).

---

10. For more detailed information, see appendix C: "The counterfactual approach in transportation economics."

Figure 12. Scenario SLOC blockages and alternative routes



Scenario I. The Malacca Straits

The Malacca Straits close, along an invisible line to the west of Singapore. No ports are blocked, and all ships and cargoes noted in 1993 move, but Malacca Straits traffic is rerouted. Vessels calling at Singapore are hypothesized to still call there, but all such traffic approaches Singapore from the east. The typical reroute is via the Sunda Strait, which of course becomes very busy.

Scenario II. The Malacca Straits and the Port of Singapore

In addition to the straits closing to the west, Singapore also closes. The port blockage means that voyages to and from Singapore are canceled, and shipments of cargo into and out of the port do not move at all. Singapore's maritime exports are bottled up, unable to leave, and imports are shut out, unable to get into the city. Note that this results in fewer voyages being detoured (because some voyages are canceled), and hence less deviation cost than in the first scenario. However, the cost of lost trade should be considered as part of the total economic costs of the disruption. As before, the typical reroute for voyages that do move is via the Sunda Strait.

Scenario III. The sea lanes passing the Spratly Islands

A hypothetical invisible barrier arises between the northern tip of Sabah on Borneo and the southern tip of Vietnam. No voyages are canceled, and all imports and exports get through. All international traffic in large vessels is rerouted if it crosses the hypothetical line. The north-south sea lanes in the South China Sea passing the Spratly Islands are simply unavailable to commercial traffic. Note that this is not a geographic chokepoint *per se,* but a "strategic high seas SLOC." The principal alternative route is via the Straits of Lombok and Makassar.

Scenario IV. The Straits of Malacca, Sunda, and Lombok

The southern entrances to the South China Sea and Lombok-Makassar SLOCs all close. Ports nearby in the region shut. It is assumed that other, shallower and/or narrower, passageways through Indonesia, such as the Ombai-Wetar Straits, aren't available as alternative routes. Another assumption is that the Torres Strait is unavailable, even for smaller vessels whose draft does not exceed the channel limitations. International long-haul shipping reroutes south of Australia.

The first scenario is consistent with events that close Malacca to merchant traffic, for whatever reason, and the second hypothesizes that such events disrupt Singapore shipping as well. The third might describe the impact on shipping of a maritime conflict on the high seas of the South China Sea, perhaps related to the Spratlys. Note that the last scenario is similar in effect to a closure of the Spratly Island SLOCs by events that spilled over into the Strait of Makassar and closed them also. Alternately, events in Indonesia could conceivably close the southern entrances. The last scenario may be viewed as a "worst case." Perhaps a serious regional war, or extreme civil war, could have such an effect.

Evaluating the scenarios

How would a SLOC closure in Southeast Asia matter to the world shipping markets and, by extension, to the rest of the world economy? Two time horizons are of interest: the *short-run impact* and the *long-run impact* of a sea lane disruption. Economic analysis typically copes with static equilibrium models better than with dynamic models. Calculations on the economic costs of shipping detours provide information on the initial equilibrium and the final equilibrium, the beginning and the endpoint of the dynamic analysis. The calculations also assess the impact of Southeast Asian SLOC disruptions on world shipping markets.

Short-term consequences

In the short run, what matters is the size of the traffic diversion—how many ships are diverted and how far they must detour. If a sea lane closure diverts enough volume of traffic long enough distances, the resulting shock could send freight rates up. On the other hand, if a small amount of traffic is diverted a small distance, any oversupply of merchant capacity will simply absorb the shock.

The detour voyage of every vessel detected going through the key SLOCs, and the extra ton-miles and ship-days required for the diversion was traced and calculated. Concern for the short run reflected the magnitude of the extra demand for shipping generated by the scenario, and whether the extra demand would cause a shortage of shipping worldwide, driving up rates.

What scenario events might disrupt the balance of supply versus demand in the world shipping fleet? If the extra capacity required is large enough, demand will exceed supply for a time, and freight rates will be high. Either the fleet will then expand to meet demand, or the events associated with the shock will go away. If the shock is small, any "blip" in demand will be absorbed by the market, with little effect beyond the SLOC in question. Additionally, if shipping is (at the time a scenario occurs) either "loading less-than-capacity," or if there is a glut of shipping on the market, a detour (short term) would have minimum effect.

Two scenarios (I and II) are "purely detour"; ships must sail farther, increasing demand for shipping. Two others (III and IV) assume that, in addition to detours, some cargoes are not shipped because of port blockage, offsetting to some extent the increase in demand.

For each scenario, the *extra* ship-days required for additional steaming were calculated. The extra cargo capacity required for each scenario also was compared with the

amount of incremental shipping capacity readily available. Where the estimated incremental ship-days are large compared to capacity available, rates will go up.

Long-term effects

In the long run, one variable that matters is the extra steaming costs initially incurred by vessels steaming longer routes. If the disruption causing a forced detour persists, the size of the world fleet will eventually adjust to eliminate any capacity shortfall. Freight rates will return to normal for the rest of the world, in due course. However, one "floor" for freight rates is vessel operating costs. So, it is necessary to calculate the incremental vessel operating costs for vessels *actually* diverted. The long-run impact on freight rates of the diversion will be proportional to these incremental operating costs. This long run impact mainly will be limited to routes where detours are required, should the closure persist, and will not affect rates or supply in the rest of the world significantly.

Freight rates will be mainly determined by transportation costs, and supply will adjust to accommodate demand. The long-run impact is a function of incremental steaming costs if a closure occurs, and no other form of sea lane or trade disruption accompanies the SLOC closure. Only the trading partners who relied on the closed SLOC usually will be affected. Vessels trading between them must now sail farther. The shipping market will eventually adjust for any disruption in the supply-demand balance. In the long run, the supply of maritime transport services is infinitely elastic because with time any number of ships can be added to the fleet, cargo loading can be adjusted, steaming speed can be changed, etc.

For each route on each scenario, the extra costs of sailing the route were calculated should a disruption occur. These costs were traced to specific goods and trading partners, and looked at for their impact on a market-by-market basis.

Shipping costs, freight rates, and the shipping business cycle

The supply of vessels versus demand for shipping services generally determines freight rates in the short run. Usually, competition drives down rates in the long run. In the short run, the size of the shipping fleet is fixed, and it takes time to increase the size of the fleet. If there is a surge in demand for some reason, so that demand for shipping exceeds available supply, rates will increase. Increased rates present profit opportunities to entrepreneurs, thus attracting additional resources into shipping and the fleet will expand to whatever size is required to accommodate demand. In the long run, costs

will again stabilize. In economic terminology, prices equal marginal costs in market equilibrium.

In the short run, temporary imbalances of supply and demand cause freight rates to deviate from their cost-dictated long-run equilibrium. There is typically an oversupply of vessel capacity on the market, with idle or underutilized capacity available. Usually, this oversupply ensures that only the more efficient operators make money. Freight rates may occasionally dip below operating costs due to low demand. They may stay down until total capacity available shrinks, as owners scrap older vessels, or until events cause demand to pick up. High freight rates encourage owners to squeeze more service out of the existing fleet in the short run, and to add to the fleet in the long run.

If demand picks up, rates may climb over average costs (defined as operating costs plus vessel financing costs plus overheads). With both plenty of cargoes and high freight rates, existing vessels make good profits for a time. Operators launch new vessels and stop scrapping old ones, supply can catch up rather quickly, and oversupply soon drives down rates toward operating costs again. It takes only nine months to build a big merchant vessel, and there is plenty of typically idle shipyard capacity, so the "long-run supply response" could in theory be rather quick.

Freight rates and the merchant fleet operating tempo

When rates are low, vessels are operated in the cheapest possible manner. With too many vessels chasing too few cargoes, there is not much incentive to try to maximize throughput because additional cargoes are not readily available. Ships reduce their "fuel burn," saving money by steaming at "slow service speed," and often operate with underutilized cargo capacity. They may spend idle time at ports or turn around relatively slowly during port calls. What might be called the *operating tempo* of the merchant fleet is slow when rates are low and excess capacity is readily available.

When rates are high, profits can be made on the higher margin of rates over costs. Vessel operators take steps to pick up their throughput of ton-miles of transport service to increase revenues. They increase their speed, operating at "design speed" rather than "slow service speed." They make efforts to turn around more quickly in port. *All in all, about 10 percent more ton-miles of capacity is available from the same fleet when rates are up.* Faced with higher rates and tighter supply, shippers pack cargoes on vessels more carefully. For a time, operators can defer routine maintenance. The operating tempo of the merchant fleet is fast when rates are high, and little excess capacity is available.

The statics and dynamics of freight rates

A typical approach is to evaluate two market equilibria, an initial state and an end state, a process known to economists as *comparative statics;* then, evaluate what dynamic process can move the market from the initial condition to the final condition.

In the supply-demand framework, assume that the shipping market is stable and clearing. That is, suppliers and demanders are in accord, economically speaking. Freight rates and the fleet are stable. There is the usual amount of supply overhang in the merchant fleet. The market is a global market. Ships steam slowly from port to port, sometimes not fully loaded, and operate in a cost-minimizing mode.

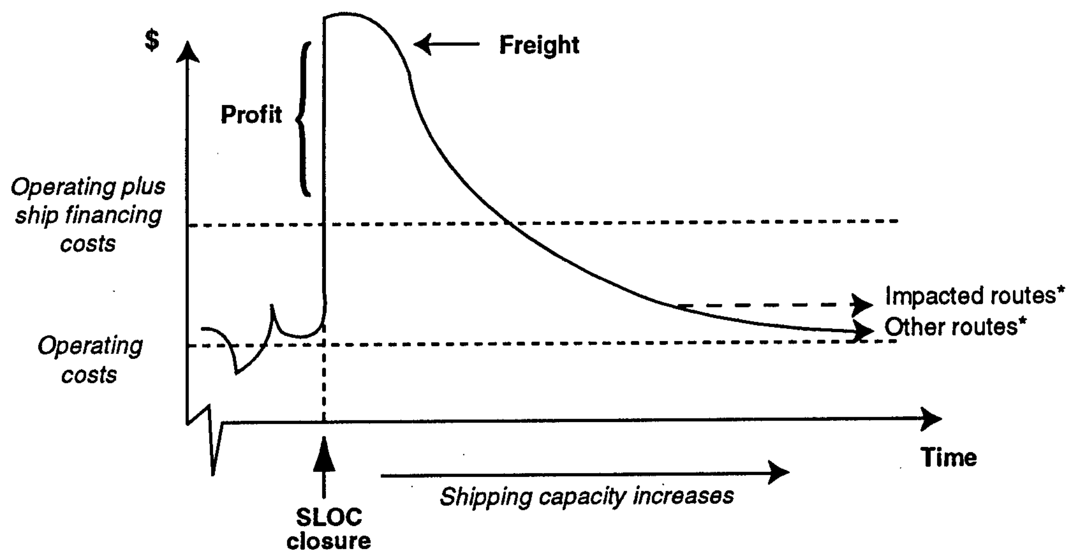
Suppose events occur that increase the need for ton-miles, and thus the demand for the services of additional merchant vessels. Or, perhaps a key SLOC is closed, requiring vessels to steam farther to deliver the same cargoes. Assume that the demand shifts. If it shifts a "small" amount, the excess supply available simply soaks up the extra demand, and freight rates don't move at all. That would be a minor "demand shock" to world markets, and would have no repercussions outside the directly affected routes.

Suppose, however, that the shock is "large" with respect to the supply overhang. A rise in world freight rates will coax additional ton-miles out of the existing world fleet. The higher rates will be necessary to pay for the increased fuel burn per ton-mile at higher speeds, and also encourage operators to turn around in port rapidly, and motivate shippers to fully load vessels. At higher rates, deactivated merchant ships will reactivate, further increasing supply. In the long run, new vessels will be built, the upward "kink" in the supply curve flattens out, and rates return to their normal levels.

If the "demand shock" is large enough, rates will jump to high levels. This has two functions: it encourages the short-run and long-run supply response, and it rations the limited supply among users according to price. The rate jump applies world over, not just to the affected routes. The critical empirical question, then, is whether these scenarios generate an increase in demand that is large compared to the unemployed capacity immediately available.

Figure 13 depicts the hypothetical path of freight rates over time, we see that a large demand shock occurs. Rates jump, recede somewhat as additional supply is squeezed out of existing capacity, and then slide slowly downward as additional capacity is added to the fleet. Both the elasticity of supply and the elasticity of demand for maritime transport is inelastic in the *short* run, so it may require temporary wide swings in prices to balance supply and demand.

Figure 13. Freight rate fluctuation over time adjustment to an upward "demand shock"



* Routes impacted by a SLOC blockage will require higher freight rates in long-run equilibrium due to longer voyages. Rates on other routes will settle down to operating costs in the long run.

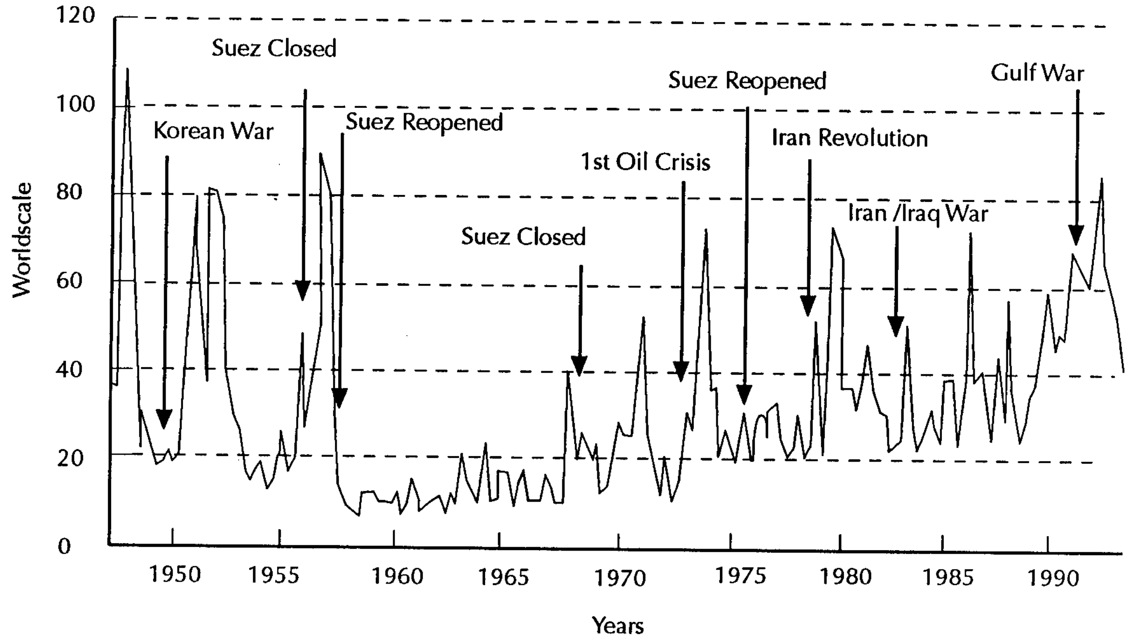
A historical look at tanker freight rates

Figure 14 shows a historical time series of "single voyage rates" for oil tankers from 1947 to 1992. Rates are converted to "worldscale," a normalization procedure. Rates are quite volatile, ranging from 10 to over 100. Notice that much of the time rates oscillate in the low range. These low periods of low freight rates correspond to times when there is excess tanker capacity. Occasionally rates shoot up, typically for a short period of time. These interludes correspond to times when the tanker market is tight, with little excess capacity. Expansion of the fleet typically removes upward pressure on rates rather quickly. In this time series, world events often correlate with spikes in rates.

The first closure of the Suez Canal in 1956 provides a historical example of the impact of a SLOC closure on rates. Ships were sunk in the canal during hostilities, forcing tankers to go south of Africa via the Cape of Good Hope. Rates soared to 90, as tanker ton-mile demand increased. The reopening of the canal released upward pressure on rates, in 1957. Rates oscillated in the 10 to 20 range for the following decade.

In the 1950s, there were no Very Large Crude Carriers, and the tanker supply-demand balance was tighter than it is today. Oil trade and consumption patterns were different. Therefore, for this and other reasons, an econometric model built on this time period would not be applicable to today's market. Still, this event does provide a guide to what might happen to rates given a SLOC blockage.

Figure 14. Tanker single voyage rates (1947–1992)



Short-run supply and demand for vessel capacity

Table 12 presents estimates of worldwide vessel oversupply for 1990 to 1994. These estimates include inactive vessels, vessels awaiting charter, ships in port more than required for typical turnaround, and so forth. A provision of 15 days per annum has been backed out to allow for average annual periodic maintenance. A rather constant oversupply existed in recent years.

Table 12. Estimates of available *excess capacity,* 1990–1994 (by DWT) as *percentage* of the world merchant fleet

Year	Cellular (container)	Liner	Dry bulk and combos	Liquid bulk	All ships
1990	22.0	20.3	13.2	10.5	13.6
1991	23.3	22.3	12.7	14.5	15.6
1992	25.3	21.9	14.3	14.8	16.2
1993	26.2	19.8	16.1	14.4	16.4
1994	24.7	14.6	15.1	14.2	15.2
1990–94[a]	24.3	19.8	14.3	13.7	15.4

a. Five-year average for 1990–94.

Note that the different types within the fleet have different equilibrium capacity oversupply rates. Container (cellular) and "liner" vessels (which travel scheduled routes) carry high-value cargoes, such as finished goods and electronics. These fleets tend to have relatively high excess capacity, over 20 percent. The dry and liquid bulk fleets typically have between 10 and 15 percent excess capacity. So, the bulk markets are less able to absorb strong shock. Yet, it is the low-value commodities that are the most sensitive to maritime freight rates.

Of paramount interest is the excess capacity as a percentage of utilized capacity, compared to the *extra capacity required by each scenario.* That is, how much more capacity is required in the scenario versus how much extra is available? By conventional wisdom among shippers, if the supply "overhang" falls to less than 10 percent, there will be upward pressure on freight rates.

Table 13 shows excess overhang in 1993 and the 1990–1994 average compared to the increase in utilization generated by scenario I. Just closing the Straits of Malacca would cause freight rates to soar, as the supply overhang would fall to less than 5 percent. The tanker market would be most affected, as *all excess supply would be absorbed.* Virtually all excess capacity in the world fleet would be soaked up by forced detours. Experience indicates that rates for shipping oil might triple in the short run. The dry bulk market would also feel a shock, although a less severe one than that in the liquid bulk market. The container market would be least affected.

Table 13. Scenario I: Straits of Malacca closed (detours only, no port blockages)

Ship type	Excess capacity available as a percentage of utilized capacity: 1993	Excess capacity available as a percentage of utilized capacity: 1990–1994 (average)	Increased capacity required if Malacca Straits closed (%)
Container	26.2	24.3	11.7
Liner	19.8	19.8	13.0
Bulk and combo	16.1	14.3	8.8
Tanker	14.4	13.7	13.4
All ships	16.4	15.4	11.8

So much merchant shipping passes through the Straits of Malacca that closing the straits would disrupt shipping markets all around the world. Delays would occur, the operating tempo of the merchant fleet would quicken, and idle vessels would quickly find charters. However, the excess capacity available would still move the trade. The following two scenarios (*detour only*) emphasize the problem.

Table 14 shows increased capacity required if the SLOCs in the South China Sea passing the Spratlys are cut. This scenario assumes a cutoff of the main artery of Southeast Asian trade, forcing it around the Philippines. The effect on the liner and cellular trade is impressive. All the world's capacity overhang in these markets is absorbed by the detours. The shock in the dry bulk markets is similar, even though much of the region's dry bulk already passes through the Straits of Lombok and Makassar. The immediate effect on the tanker fleet could be extreme for consumers worldwide, and a bonanza for shipowners. Freight rates for liquid bulk would jump and, until the world fleet adjusted, outright shortages of tanker capacity could occur, and some trade might not move on time.

Table 14. Scenario III: Spratly SLOCs closed (detours only, no port blockages)

	Excess capacity available as a percentage of utilized capacity		
Ship type	1993	1990–1994 (average)	Increased capacity required if Spratly SLOCs closed (%)
Container	26.2	24.3	23.6
Liner	19.8	19.8	23.8
Bulk and combo	16.1	14.3	16.5
Tanker	14.4	13.7	23.3
All ships	16.4	15.4	21.2

Disruptions of the type hypothesized (detours) could cause a large jump in maritime freight rates. All buyers of shipping services would bear pain for a time. Over time, should the SLOC closure continue, shipping supply could expand and absorb the blow. Uncertainty might delay or inhibit the supply response function. And, even in the worst scenarios, most cargoes would continue to get through.

The exact magnitude of this global effect is hard to forecast, given the lack of comparable examples or "data points." Furthermore, the impact would depend on such factors as the world shipping supply-demand balance at the moment, and the specifics of the scenario events. When the Suez Canal was blocked, tanker rates went up about 500 percent, albeit under tighter market conditions than exist today. This shock would be roughly similar, perhaps larger—since more shipping is affected by SLOC closure in Southeast Asia.

Long-run economic impact

Were a SLOC closure on the Southeast Asian high seas to continue for an extended period, forcing vessels to detour on a continuous basis, the shipping market would adjust eventually. In "equilibrium," the size of the fleet would accommodate demand. With supply and demand for shipping again in balance, the additional cost of longer voyages would determine the increase in freight rates.

Figure 15 shows the balance of supply and demand for a given commodity on a given trade route. The extra costs of shipping the commodity from source of supply to country of consumption can be thought of as a "tax." This tax drives a wedge between the price to the supplier and price to the consumer. Like any tax, it is an economic distortion, and tends to reduce the quantity traded. The economic impact is a function of the size of the tax. Who pays the extra costs depends on the relative price elasticity (sensitivity) of importers versus exporters.

Figure 15. Demand and supply for imports and exports on a trade route

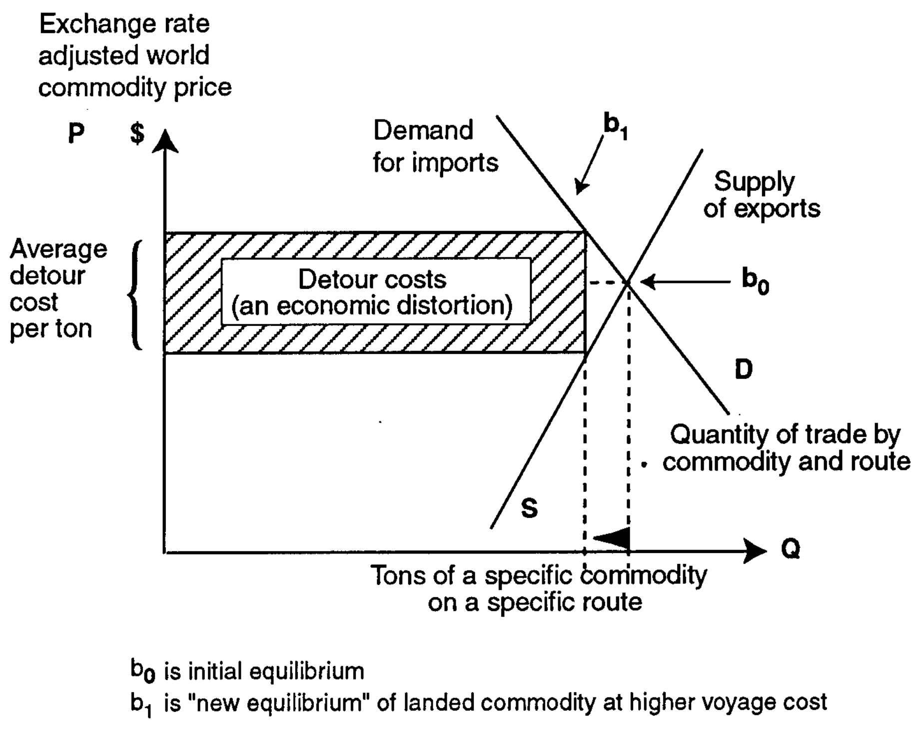


Table 15 shows estimates of the "average tax equivalence" rates for three of the scenarios. While the extra shipping costs (in the numerator) are large in absolute terms, the volume of trade (in the denominator) is very large. Typically, forced detours of

shipping on the high seas add proportionately small (but significant) costs to ultimate consumers, once the shipping industry has adjusted to the disruption of supply and demand.

Table 15. Detour costs by scenario[a] (total increased voyage costs and costs as a percentage of cargo value)

Closed SLOCs	Detour costs ($ billions)	"Average tax equivalent" (percentage)
I. Malacca Straits	1.3	0.2
III. Spratly SLOCs	3.1	0.5
IV. Malacca, Sunda, and Lombok Straits	7.4 (annualized)	2.2

a. Last scenario assumes that some ports and cargoes are blocked. Trade interruptions generate economic losses but no "detour costs." Right column is total extra steaming costs, divided by value of cargoes diverted. Corresponds to scenarios I, III, and IV.

Unlike the short-run freight rate impact, which may be global, the long-run shipping cost impact is route specific. The extra shipping costs per ton depend on the distance of the detour. The economic impact of these costs depends on the value of the commodity per ton. Table 16 shows detour cost and tax equivalence estimate for *representative commodities on typical routes.* The major trade flows are not particularly seasonal, although one may assume linearity for diversion costs as a first-order approximation. For example, the cost of a one-month diversion can be estimated by dividing the annual cost by twelve.

Iron ore is one of the lowest value commodities shipped by sea. Closing Malacca would affect iron ore shipments through that SLOC, especially if Australian iron ore had to divert south around Australia. Australian producers would have to absorb a large increase in transport costs to market, reducing their revenues from sales by 24 percent, or lose their business to other sources.

Crude oil from Arabia could cost Japan nearly $200 million per year more if the Spratly SLOCs closed, but import costs for oil by this particular route would increase by less than 1 percent. If Arab *crude and gas* had to go around Australia, at least $1.5 billion would be added to the Japanese energy bill—and that does not take into account possible cutoff of Southeast Asian imports. High-value electrical equipment is essentially unaffected.

Table 16. Annual detour costs, and extra shipping costs as a percentage of cargo value, for selected routes and commodities, by scenario

Cargo	Route	Detour cost[a] ($ millions)	As percentage of value
	Malacca closed (Scenario I)		
Iron ore	India–Japan	16.2	4.0
Crude oil	Arab Gulf–Japan	87.9	0.4
Electrical equipment	Japan–N. Europe	17–21	0.1
	Spratly SLOCs closed (Scenario III)		
Iron ore	India–Japan	22.6	5.5
Crude oil	Arab Gulf–Japan	192.3	0.9
Electrical equipment	Japan–N. Europe	28–36	0.2
	Malacca, Sunda, and Lombok closed (Scenario IV)		
Iron ore	Australia–China	72.8	24.4
Crude oil	Arab Gulf–Japan	1,200	5.6
Gas	Arab Gulf–Japan	322.7	12.7
Electrical equipment	Japan–N. Europe	112–141	0.6

a. Detour costs include incremental vessel operating costs and financing for hulls and cargo holding costs, due to longer voyages. Costs are reported on an annual basis, and are specific to commodities by route. Bulk cargoes are costed round trip, including ballast leg. Range given for finished goods by liner or container. Base year: 1993.

Denial of ready access to high-seas Southeast Asian SLOCs would negatively affect suppliers and consumers of cost-sensitive low-value bulk cargoes. The global trade patterns of bulk shipments could be permanently affected. Consumers would face higher prices for energy and raw materials. Some suppliers might be forced out of the market—others might benefit.

Countries closest to the "closed" SLOCs are hurt most by diversion. The reason is that typically the detour is a *bigger percentage of the total voyage* than for through-bound traffic going half-way around the world. Although the percentage of value comparisons are similar to other regions, countries in the Southeast Asia region (Vietnam, Cambodia, Thailand, Malaysia, Singapore, Indonesia, and the Philippines) rely heavily on seaborne trade, thus much of their trade is affected. Figures underestimate the effect because they do not include domestic, intraregional, and small fishing-boat trade. And interregional trade numbers capture only about half of the tonnage traveling to and from the Southeast Asia region because several of their countries do not fully report trade statistics. The implication is that littoral states and states in the region have a vested interest in free trade: a stabilizing factor, and a deterrent to any interruption of commerce.

Keep in mind that both the short-run freight rate impact and the long-run transport cost impact commence the moment SLOC closures force vessel detours. In that sense,

they are cumulative. This initial coincidence of impact tends to ensure that the trade route and the SLOC in question bear the brunt of the impact. That is, the global (freight rate) impact and local (shipping cost) impact occur simultaneously.

The first graph in figure 16 shows the distribution of increased shipping costs by destination, a measure of the "incidence" of the "tax."

Lost trade due to port blockage

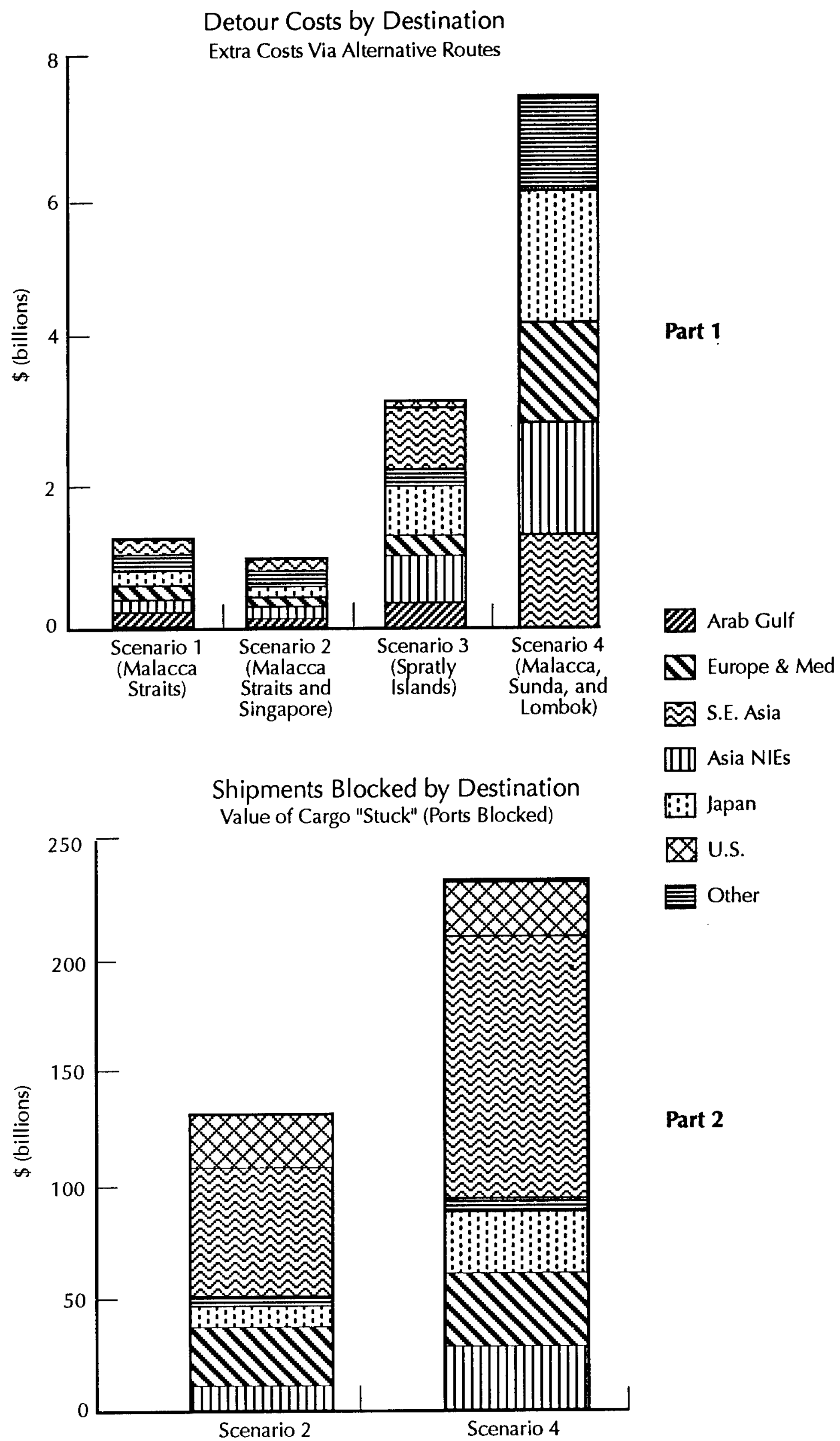
If the Port of Singapore closed in 1993, along with the Straits of Malacca and some adjacent ports, some $130 billion in cargoes might not move (figure 16, part 2). To arrive at that estimate, assume that all cargoes transshipping through Singapore would find another route to their final destination. Most cargoes landing in Singapore are loaded back onto other vessels. This $130 billion is an estimate of Singapore-produced exports and Singapore-destined imports traveling by sea. This scenario is a modification of the "Malacca closure-detour only" scenario. "Detour costs" can be expensive. "Blockage costs" are exorbitant on a long-term basis.

If southern Southeast Asian ports closed in 1993, in Singapore, Malaysia, and Indonesia, perhaps $232 billion in cargoes might be trapped in port. Many of these trades would be stopped in either scenario because Singapore conducts a lot of trade with its neighbors. These blockages are part of the scenario that postulates simultaneous closures of the three southern entrances: Sunda, Malacca, and Lombok.

Part 2 of figure 16 shows the distribution of national trades blocked or canceled in this latter scenario by destination region. The impact of port blockages or interrupted trade links is concentrated here on the region where it occurs, Southeast Asia. Imports and exports tend to balance for most economies. So, about half the interrupted trade in this scenario is Southeast Asian exports bottled up in port. The other half are Southeast Asian imports, which are blocked out.

The economic costs of *blocked* trade are much larger in magnitude than *detour costs* in these scenarios. Suppose all that was lost economically due to interrupted trade was the value added by the exporter. Suppose further that the value added was only 20 percent of exports, a typical if conservative assumption. By these assumptions, the economic costs of scenarios II and IV are 20 percent of the volume of *blocked* trade. If so, these two scenarios cost the world economy $26 billion and $46 billion, respectively. In contrast, the scenario *detour costs* (figure 16, part 1) ranged from $3.5 billion to $8 billion. This is understandable, as maritime transport costs to "detour" around obstacles is cheap, whereas the value of international trade "blocked" from moving by sea is very large.

Figure 16. Scenario impacts by destination (1993, annualized)



Note that even a short-term "blockage" that only temporarily interrupts the flow of trade may not be serious. If cargoes are merely delayed, the only costs incurred are holding costs and perhaps deterioration. There, costs are minor, and constitute mere inconvenience. Care must be taken to distinguish between events that prevent trade from occurring (a costly event) versus events that merely delay shipments (an inconvenience).

Economic impact is underestimated for littoral states

Calculations understate the scenario impact for states closest to the closed SLOCs. One major factor is maritime activity and vessel movements not included in the database. Another factor is that port closures or trade blockages are much more likely to affect economies close to the closed SLOCs. Here is a list of factors that cause our estimates of increased economic costs due to forced detours to be biased *downward* for the nations of Southeast Asia.

- *Data underreporting.* Southeast Asia is considered to be a "nonreporting region" so far as trade and ship movements are concerned. Some interregional data are based on "mirror statistics," Southeast Asian movements inferred by information collected outside the region. Intraregional movement data are particularly underreported. The net effect of full reporting of regional maritime statistics would be to increase the activity recorded for regional economies. Calculations of the economic costs of SLOC closure would increase for regional and especially littoral states.

- *Unreported domestic trade.* Three of the four scenarios assume disruptions in Indonesian or Malaysian waters. For obvious reasons of geography, much Indonesian and Malaysian domestic trade moves by sea, and some moves through the strategic sea lanes that are conceptually "closed." Were this traffic included, the detour costs calculated for Indonesia and Malaysia would increase.

- *Intentionally misreported trade.* Smuggling and tax evasion are common in parts of the region, as it is in many parts of the world. This practice often involves nonreporting or misreporting ship and trade movements. If properly recorded, such traffic would increase the calculated impact of forced detours for littoral states.

- *Small vessel traffic.* Data on vessels smaller than 1,000 DWT were not included in the database. Short-haul regional traffic quite often moves by small vessel, while long-haul interregional traffic rarely or never does. Some trade on small vessels moves through the chokepoints. Including it would increase the costs calculated for economies littoral to the strategic SLOCs.

- *Other maritime activity.* Only merchant ships carrying cargoes were considered. Other economically valuable maritime activity includes fishing, hydrocarbon extraction, transport by ferries, passenger vessel transport, lightering, tugboat activity, recreational boating, and the like. All such activity is typically linked to the nearby littoral economies, and rarely has anything to do with distant ex-regional economies. Factoring disruption to miscellaneous maritime activity into the calculations would increase scenario costs to littoral economies.

Taking into account the above information would not change the detour costs calculated by much for, say, Japan or the Newly Industrialized Economies. These economies' maritime interests in the South China Sea are almost exclusively represented by the large merchant ships on international long-haul voyages, which the database captures very well. However, factoring in the above under- or unmeasured traffic for the economies of states in the Southeast Asian region, and especially states along the sea lanes, would raise the estimate of their costs due to SLOC closure. Not only would total estimated economic costs increase, but the estimated distribution of costs would shift toward Southeast Asia and countries immediately adjacent to disrupted sea lanes.

Chapter 4. Interpretations and conclusions

Are sea lane disruptions that force vessels to detour reason enough for war? Certainly nations might go to war if access to key markets is disrupted. The threat of Iraqi dominance of Mid-East oil supplies may partly be an explanation for the 1991 Gulf War. But what if ships must detour?

Faced with the prospect of East-West nuclear war and perhaps mutually assured destruction, traditional geopolitical and military concerns faded into the background. Most traditional military missions, such as SLOC protection, were simply "lesser included cases." Now, given a reduction of East-West tensions, the "lesser missions" deserve a closer look.

The concept of "national interest" is a broader concept that contains within it the rubric of "threats to national security." Now, simple threat analysis no longer provides all answers about military priorities. Analysts must broaden the scope of their arguments to include interests, if they are to advise policy-makers well on matters of force levels and force mix. To assess the economic national interest, it is necessary to study economics and trade flows.

Interests of regional trading nations

Japan depends heavily on crude oil shipped through the straits. Eighty-five percent of the Japan-bound crude transiting Southeast Asian waters comes all the way from the Arab Gulf. Over half the crude oil entering Malacca in 1993 from the Gulf went on to Japan. Japan is not well diversified, so far as oil sources are concerned, and depends on the Southeast Asian sea lanes to bring in energy imports. The Japanese tanker fleet is dedicated to the South China Sea SLOCs. About 95 percent of Japanese-owned tanker capacity, including all 79 of their Very Large Crude Carriers (VLCCs), plied the South China Sea moving crude to Japan in 1993.

Although the biggest fleets (by flag) plying Southeast Asian waters are Liberian and Panamanian, Japanese-based interests *own* the lion's share of the region's shipping capacity. Because 78 percent of the Japanese-owned vessels passing through the Straits of Malacca in 1993 were flagged out, Japanese shipping interests in the region are discreetly understated at first glance. Japan would suffer most in the event of any long-term blockage of the SLOCs.

Australia ships large volumes of bulk exports north via the Straits of Lombok and Makassar, and brings in a large percentage of its imports by the same route. Australian iron ore and coal are the main tonnages entering Lombok. These low-value-per-ton exports are a vital foreign exchange earner. Because of competition on world markets, they are very sensitive to transport costs, and hence to trade route disruptions. Australia has a vital maritime economic interest in ensuring the security of the Lombok-Makassar route.

The cost of lost trade hits Southeast Asia hard. Various factors cause "local" costs to Southeast Asian countries to be underestimated. Unreported and misreported trade, and small vessel traffic, virtually ensure that economic activities important to Southeast Asia are omitted from the analysis. Some scenarios hypothesize that ports are blocked, and this class of loss will affect regional and littoral economies more than ex-regional economies. The closer an economy is to the disruption, the harder it will be hit.

Maintaining alternative sea lines of communication

The potential economic costs of closing the main shipping artery of Southeast Asia, Malacca, and the SLOCs passing the Spratlys is mitigated by the alternative routes offered by the Straits of Lombok and Makassar, and the Sunda Strait. Should world events lead merchant shipping to be wary of the main routes, the availability of alternative routes through the Indonesian islands could reduce the negative impacts to the world economy. The question is, would the Lombok-Makassar alternative remain open?

Suppose conflict in the Spratlys flares up, leading to prohibitive maritime insurance rates on South China Sea voyages near the area. This might influence the cost-minimizing calculations of vessel operators, leading them to prefer the Lombok-Makassar route for financial reasons if Lombok-Makassar were deemed "safe" by insurers. The world economy would suffer less if political arrangements could be made to contain the quarrel to the South China Sea, and ensure that the conflict did not spill over into the Lombok-Makassar alternative.

Economic and political interests, and geography, on balance, should work to keep open strategic straits. Countries adjacent to straits are the states most able to close them, but are also best able to defend them. Their economic interests are to keep the straits open. As closing them also would bring credible international pressure from other users, such widespread geopolitical forces and economic interests also should work to maintain a consensus in favor of commercial freedom of navigation. It is, of course, in the interest of the United States to support this consensus and vigorously assert the right of freedom of navigation on international waterways.

China, Hong Kong, South Korea, Taiwan, and Japan already receive significant amounts of commodities through the Lombok-Makassar route from Australia. Most of the North Asian economies would select the Lombok alternative if the South China Sea became dangerous (or if Malacca were unavailable).[11] Certainly Australia, with perhaps the most naval power in the region, would be loath to lose its Lombok route to North Asia. If faced with problems to the west, the Philippines would probably support the Lombok alternative to ensure the safety of shipping to the south and east. The United States is on record insisting that international sea lanes must remain undisturbed. It would appear that a U.S. sponsored consensus could be built in favor of protecting commercial freedom of navigation via Lombok-Makassar. However, a purely diplomatic consensus might not mean much if a conflict did arise in nearby waters. There is no regional military alliance with the operational solidarity of the North Atlantic Treaty Organization.

Naval and maritime policy-makers in the region may have another alternative. A future regional accord might be arrived at stressing the importance of not permitting events elsewhere to disturb the Lombok-Makassar route. This route is not yet controversial in the way that the Spratly SLOCs are. To give substance to the accord, regional navies might exercise along the SLOC. Practical considerations, such as interoperability issues, political agreements, and geographic areas of responsibility, would have to be worked out, creating a real multinational naval capability that would be available should disruption occur. Such an international arrangement could help ensure that an emergency in the South China Sea did not spread or result in trade being rerouted.

American maritime interests in Southeast Asia

Until recently, the mission to help keep open Southeast Asian SLOCs was justified in terms of geopolitical and military strategy. If war threatens, the United States needs open sea lanes to project its military power around the globe, and to deny their use to an enemy. Maritime transport has no substitute when vast amounts of war materiel must be shipped overseas.

The SLOC protection mission has both economic and military dimensions. The United States benefits economically from the free flow of trade, particularly its own imports and exports, as well as from the sale of shipping services by its merchant marine. In the 18th and 19th centuries, protection of shipping and trade was a major rationale for the existence of navies.

11. Indonesia has tried to mediate the Spratly dispute, and has also encouraged international use of Lombok-Makassar recently.

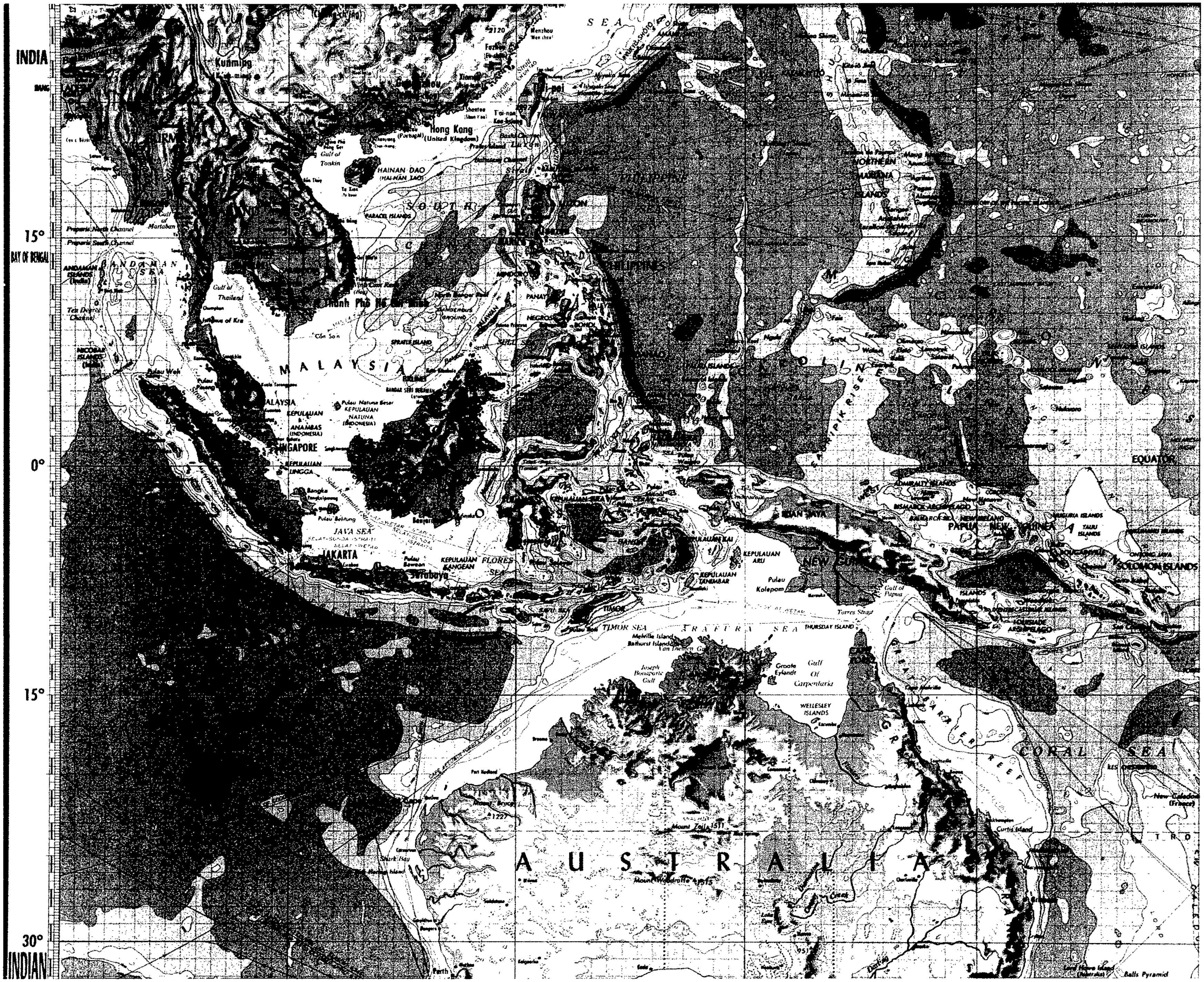
U.S.-based interests own a surprisingly large number of vessels and cargoes in Southeast Asian waters. More than 6 percent of the capacity passing through Malacca was American owned in 1993, as was nearly 5 percent of the capacity passing the Spratlys. The United States was number three in terms of capacity ownership transiting Malacca, and owned the sixth largest fleet in the study region in terms of deadweight tonnage. Most were large vessels, flying flags of convenience. The United States has a competitive merchant marine, even when its vessels do not fly the Stars and Stripes.

An analogy can be drawn between American economic interests in the Arab Gulf and American interests in the sea lanes of Southeast Asia. Only a small percentage of U.S. oil imports come from the Arab Gulf via the Straits of Hormuz, and the United States imports only about half its oil consumption. Why then did the United States view the free flow of Arab Gulf oil to world markets as vital to U.S. interests? Because, without the free flow of Arab Gulf oil to world markets, the U.S. economy might be adversely affected by high oil import costs.

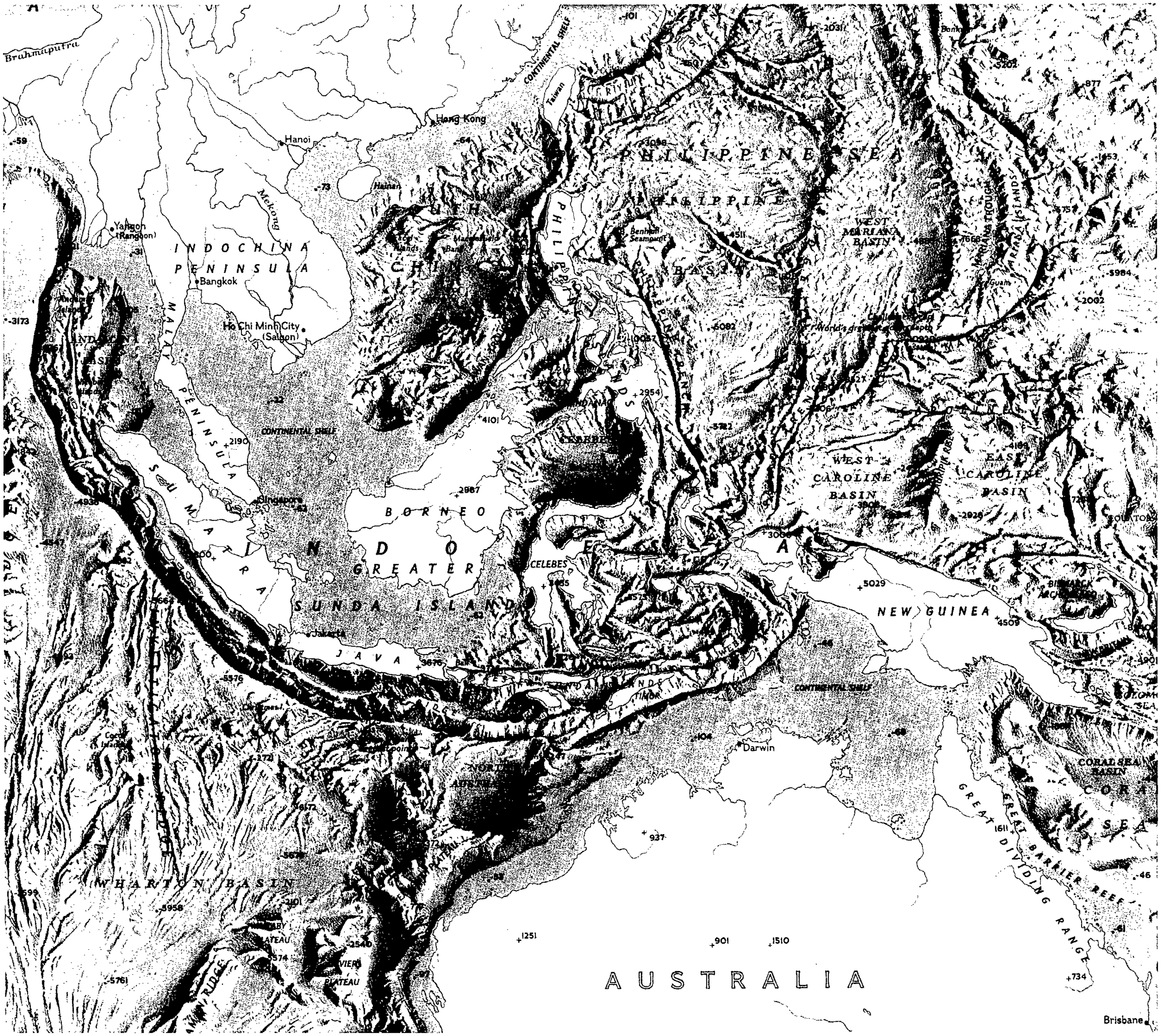
Similarly, if disruptions occurred on the high seas of Southeast Asia, relatively few U.S. shipments or vessels would be affected. However, higher freight rates, under certain closure scenarios, could raise costs for American importers and exporters, producers, and consumers in the short run. In the long run, if closure requires ships to steam longer distances, certain U.S. trading partners and allies also might be adversely affected. World markets link us all together, and give us all an interest in peace and stability.

Why are these shipping patterns of concern? United States' policies relating to protection of merchant shipping and freedom of navigation through international waters could be challenged if any blockage of these SLOCs closed sea lanes to U.S. military or commercial traffic. Any localized conflict, or unwarranted-and-enforced territorial claim over straits waters, could present a maritime crisis.

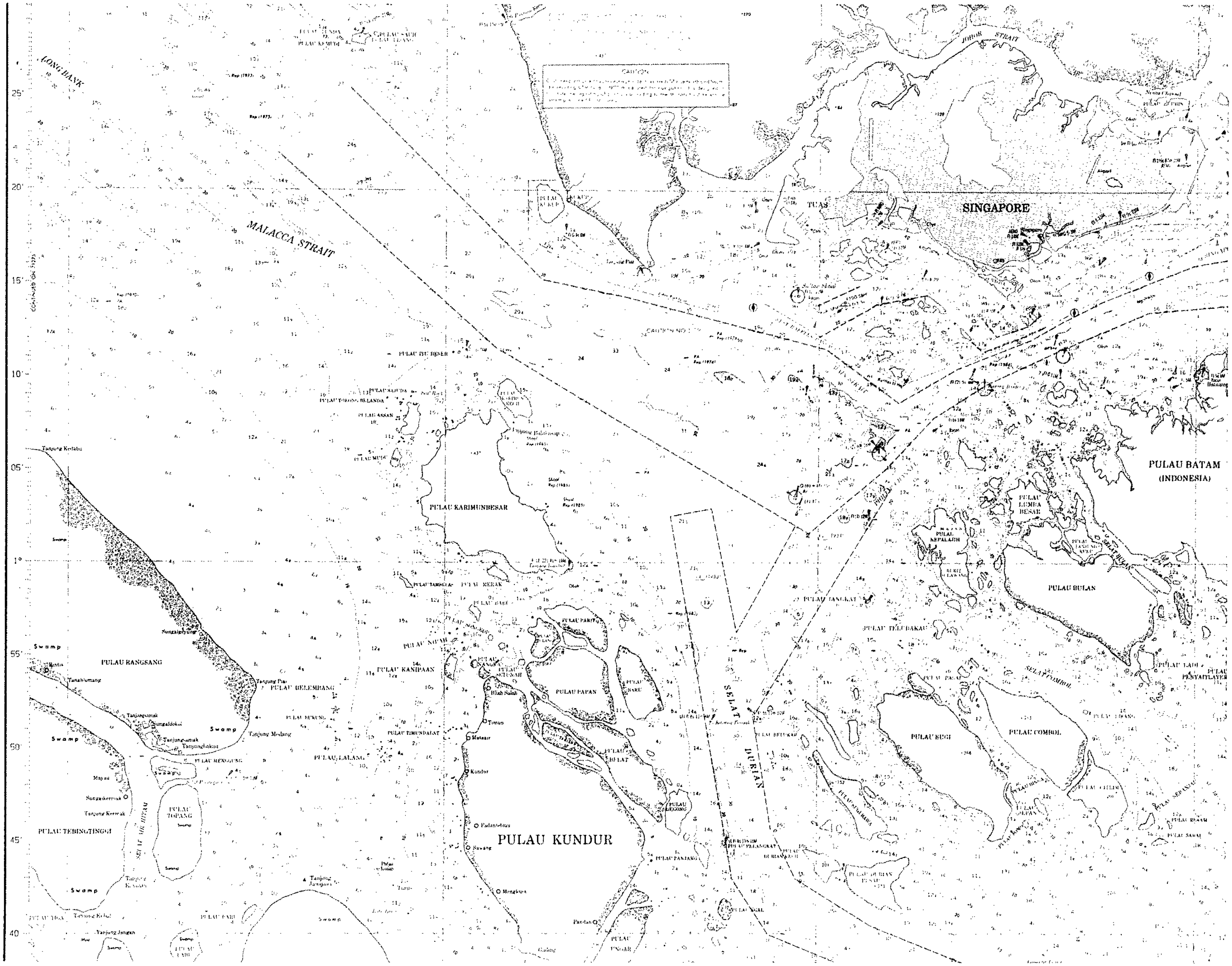
For these, as well as other political and practical reasons, the United States should continue to join and encourage other nations to address the current and potential problems of these SLOCs, including the urgent need to control shipping and regulate navigation through the chokepoints of Southeast Asia.

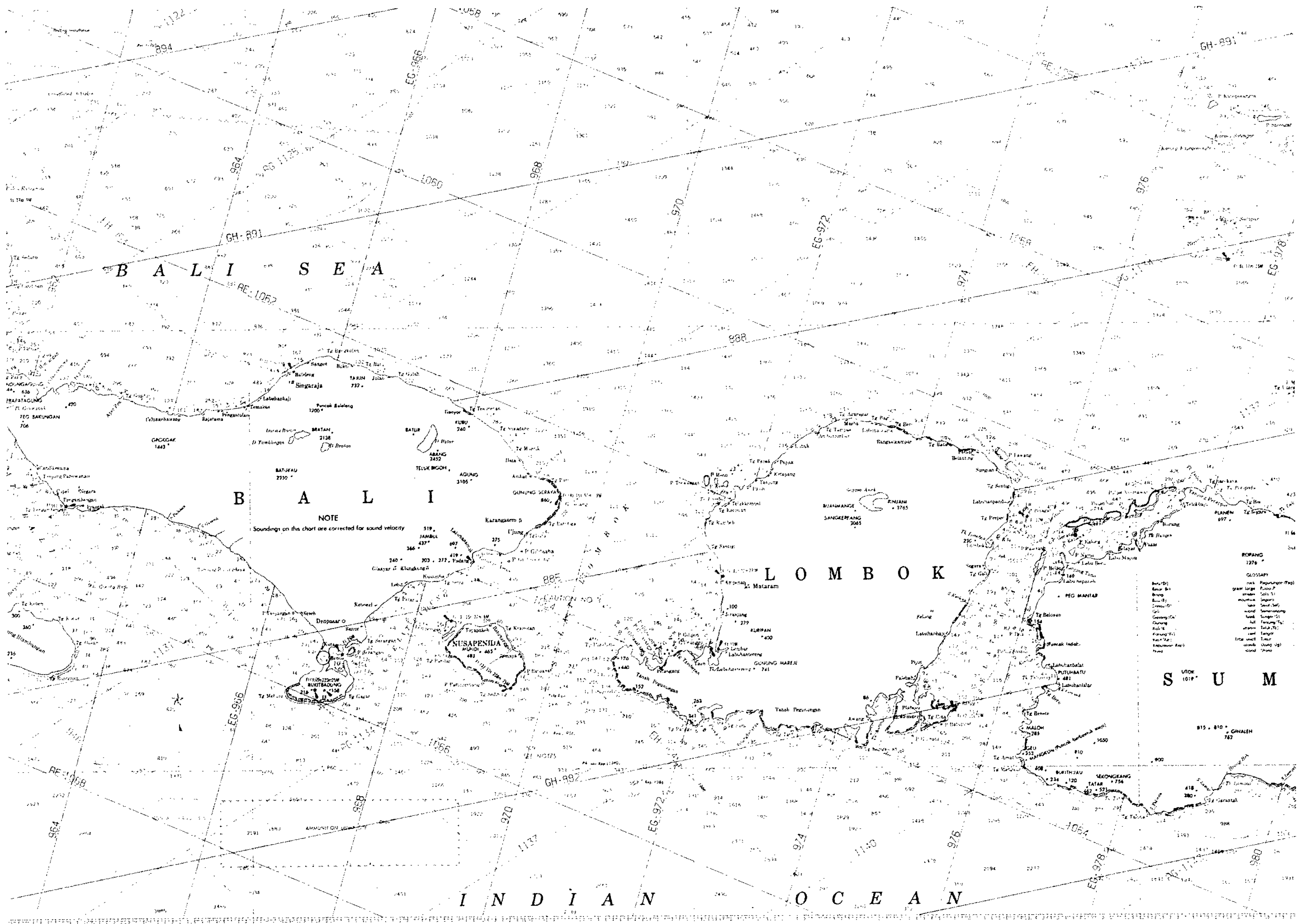


INDIA
15°
BAY OF BENGAL
0°
15°
30°
INDIAN
Kunming
Hong Kong
HAINAN DAO
Gulf of Tonkin
Gulf of Thailand
ANDAMAN SEA
MALAYSIA
SINGAPORE
JAVA SEA
JAKARTA
FLORES SEA
TIMOR SEA
ARAFURA SEA
Gulf of Carpentaria
WELLESLEY ISLANDS
Groote Eylandt
Joseph Bonaparte Gulf
Melville Island
Bathurst Island
Torres Strait
THURSDAY ISLAND
Gulf of Papua
PAPUA NEW GUINEA
SOLOMON ISLANDS
EQUATOR
CORAL SEA
New Caledonia (France)
AUSTRALIA
Mount Woodroffe
Perth
Shark Bay
Port Hedland
Balls Pyramid



Brahmaputra
CONTINENTAL SHELF
Taiwan
Hong Kong
Hanoi
Hainan
Mekong
Yangon (Rangoon)
INDOCHINA PENINSULA
Bangkok
Ho Chi Minh City (Saigon)
MALAY PENINSULA
Singapore
SUMATRA
BORNEO
GREATER SUNDA ISLANDS
Jakarta
JAVA
CELEBES
PHILIPPINE SEA
PHILIPPINE BASIN
PHILIPPINE TRENCH
Benham Seamount
WEST MARIANA BASIN
MARIANA TROUGH
Guam
WEST CAROLINE BASIN
EAST CAROLINE BASIN
NEW GUINEA
Darwin
CORAL SEA BASIN
GREAT BARRIER REEF
GREAT DIVIDING RANGE
WHARTON BASIN
AUSTRALIA
Brisbane


SINGAPORE
PULAU BATAM
(INDONESIA)
MALACCA STRAIT
LONG BANK
JOHOR STRAIT
TUAS
PULAU KARIMUNBESAR
PULAU KUNDUR
PULAU RANGSANG
PULAU TEBINGTINGGI
PULAU TOPANG
PULAU BULAN
PULAU SUGI
PULAU COMBOL
PULAU PAPAN
SELAT DURIAN
PULAU TELUDAKAU
PULAU JANGKAT
PULAU LEMBA BESAR
PULAU KEPALAJERIH
PULAU KANIPAAN
PULAU BELEMBANG
PULAU LALANG
PULAU PANJANG
Swamp
Tanjung Kelabu
Tanjung Medang
25'
20'
15'
10'
05'
1°
55'
50'
45'
40'

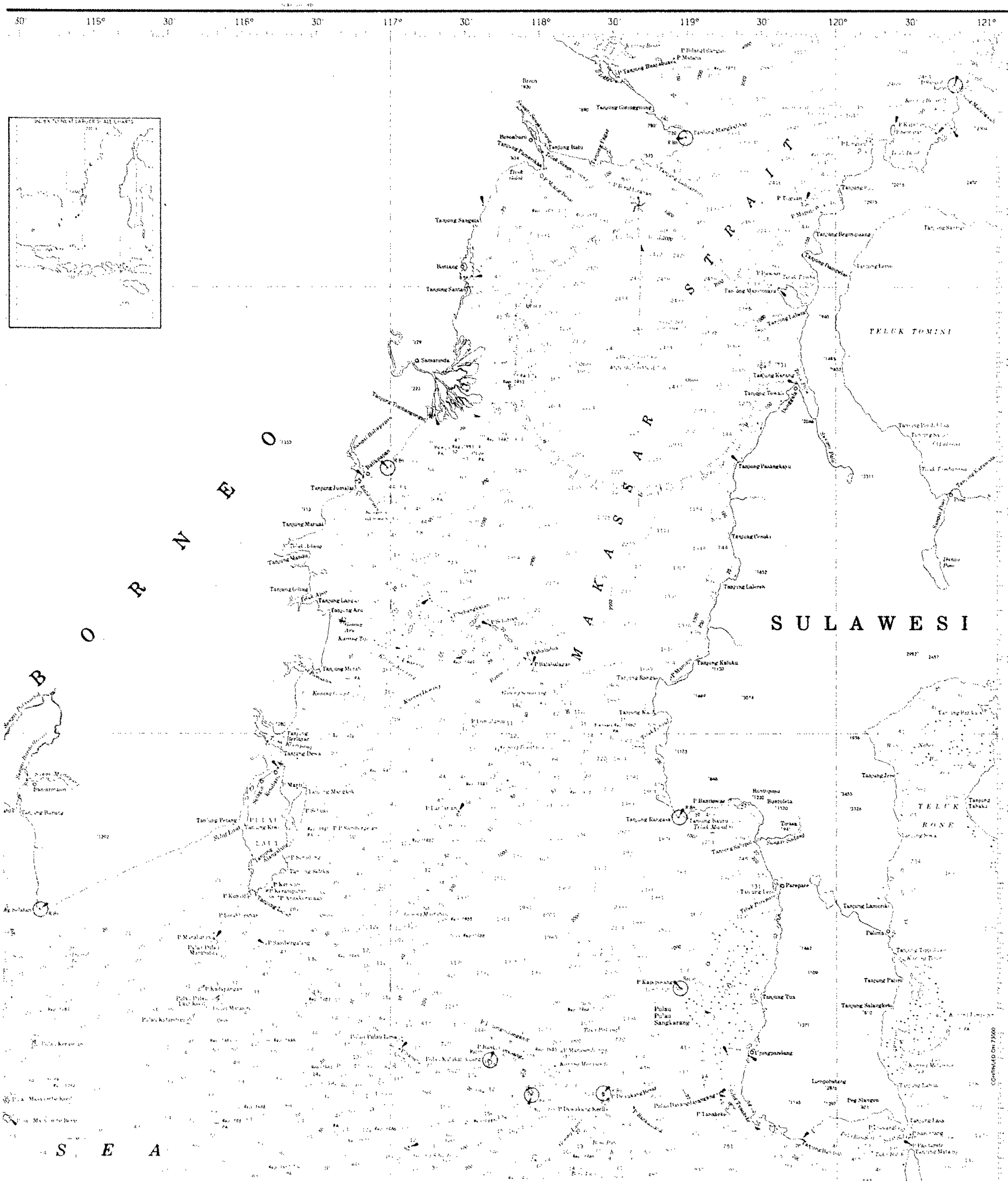


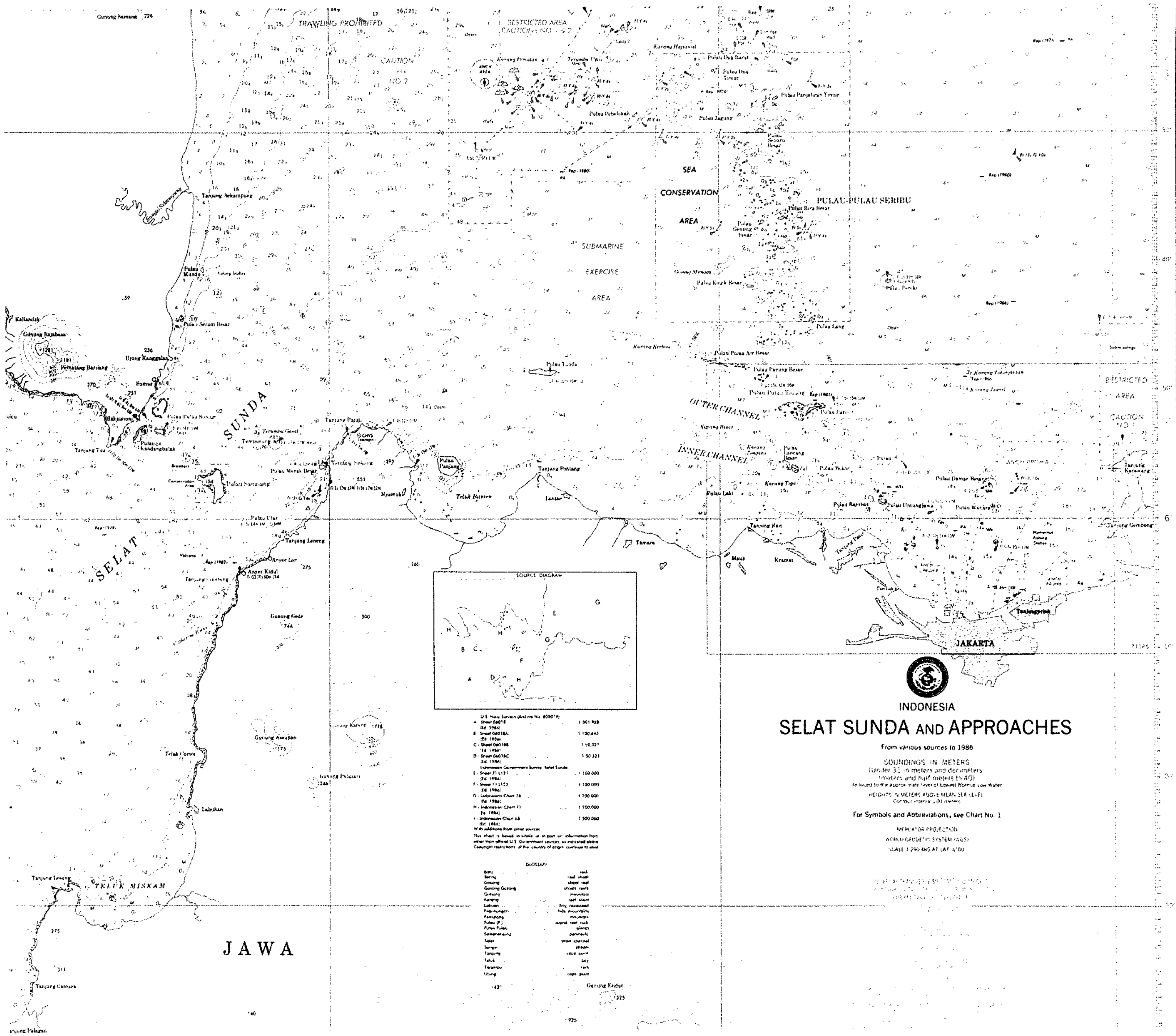
SOUNDINGS IN METERS

Prepared and published by the
DEFENSE MAPPING AGENCY HYDROGRAPHIC/TOPOGRAPHIC CENTER
Washington, D.C. 20315-0030

SOUNDINGS IN METERS

72021




INDONESIA
SELAT SUNDA AND APPROACHES
From various sources to 1986
SOUNDINGS IN METERS
For Symbols and Abbreviations, see Chart No. 1
JAKARTA
JAWA
SELAT
SUNDA
PULAU-PULAU SERIBU
SEA
CONSERVATION
AREA
SUBMARINE
EXERCISE
AREA
RESTRICTED AREA
TRAWLING PROHIBITED
CAUTION
NO 2
OUTER CHANNEL
INNER CHANNEL
TELUK MISKAM
SOURCE DIAGRAM
GLOSSARY
Pulau Sangiang
Pulau Panjang
Teluk Banten
Tanjung Pontang
Tanjungpriok
Labuhan
Anyer Kidul
Tanjung Lesung

Appendix A: Shipping patterns and trade flows in Southeast Asia

Demand for shipping is derived demand. The need for transport to move imports and exports drives the requirement for merchant vessels. Another factor is geography. Maritime transport is the cheapest mode of transport available. Any mode of air or land transport (except perhaps for pipelines) is more expensive. As a result, with the exception of high-value time-critical shipments, world trade tends to move by sea if possible.

Vessel types in the SLOCs

Supertankers alone account for more than one-third of all interregional tonnage transiting the Straits of Malacca. When small oil tankers, gas tankers, and petroleum product carriers are added, vessels that move petroleum in its various forms account for well over half of Malacca tonnage. Looking at vessel numbers rather than tonnage, most movements in 1993 were by general cargo and container (cellular) vessels. This traffic mix reflects Singapore's position as a major oil-refining center, now hosting the world's largest refinery, as well as its importance as a trading center. (See table 17.)

This distribution of ship types is essentially repeated on the SLOCs passing the Spratly Islands (table 18). The level of traffic falls off a bit, from 114 interregional transits daily through Malacca to 99 interregional transits by the Spratlys. VLCCs are a third of tonnage, and oil tankers are about half. Similar volumes of general cargo and cellular vessels are observed. Observation of the type and volume of shipping reinforces the notion that Malacca and the Spratlys are way-points on the same major route.

The vessel mix and traffic levels of Sunda (table 19) and Lombok (table 20) are much different. Sunda has the lowest traffic levels, primarily small liquid and dry bulk carriers, some petroleum carriers, and small merchants. Lombok is dominated by dry bulk carriers, which constitute over 80 percent of tonnage throughput and more than three-quarters of vessel transits. Nearly 11 ships on interregional voyages transited the Lombok Strait daily, while 9.5 per day passed through the Sunda Strait. Sunda and Lombok are secondary routes, each carrying about one-tenth the shipping of the main route via Malacca and the Spratlys.

Appendix A

Table 17. Annual flows (1993) by vessel type and direction via Malacca

Eastbound	Voyages[a]	MDWT
VLCCs (crude > 160K DWT)	1,122	286
Tankers (crude < 160K DWT)	1,895	80
Large bulk (> 100K DWT)	130	19
Bulk (< 100K DWT)	2,589	88
Product (petroleum & chemical)	2,514	74
Combo (wet & dry bulk)	82	10
Cellular (container)	3,611	86
General cargo	6,174	65
Special[b]	2,801	64
Total eastbound	20,918	773
Total westbound	20,591	793
Total transits	41,509	1,566

a. Includes only interregional ship movements of vessels over 1,000 DWT on international voyages. Does not include ferries, passenger liners, fishing vessels, warships, or any vessels not carrying cargo (such as new vessels in delivery).

b. Special includes Ro/Ro, gas tankers, reefer, vehicle carriers, and others.

Table 18. Annual flows (1993) by vessel type and direction via Spratlys

Eastbound	Voyages	MDWT
VLCCs (crude > 160K DWT)	931	234
Tankers (crude < 160K DWT)	830	56
Large bulk (> 100K DWT)	325	49
Bulk (< 100K DWT)	2,004	70
Product (petroleum & chemical)	2,028	76
Combo (wet & dry bulk)	118	17
Cellular (container)	3,330	94
General cargo	5,257	57
Special[a]	2,621	76
Total eastbound	17,444	729
Total westbound	18,583	756
Total transits	36,027	1,485

a. Special includes Ro/Ro, gas tankers, reefer, vehicle carriers, and others.

Table 19. Annual flows (1993) by vessel type and direction via Sunda

Southbound	Voyages	MDWT
VLCCs (crude > 160K DWT)	0	0
Tankers (crude < 160K DWT)	293	7
Large bulk (> 100K DWT)	53	8
Bulk (< 100K DWT)	344	13
Product (petroleum & chemical)	449	10
Combo (wet & dry bulk)	12	1
Cellular (container)	0	0
General cargo	346	4
Special[a]	162	1
Total southbound	1,659	45
Total northbound	1,794	61
Total transits	3,453	106

a. Special includes Ro/Ro, gas tankers, reefer, vehicle carriers, and others.

Table 20. Annual flows (1993) by vessel type and direction via Lombok

Southbound	Voyages	MDWT
VLCCs (crude > 160K DWT)	8	4
Tankers (crude < 160K DWT)	29	2
Large bulk (> 100K DWT)	582	98
Bulk (< 100K DWT)	1,007	40
Product (petroleum & chemical)	45	2
Combo (wet & dry bulk)	59	10
Cellular (container)	74	2
General cargo	117	3
Special[a]	140	6
Total southbound	2,061	166
Total northbound	1,839	132
Total transits	3,900	298

a. Special includes Ro/Ro, gas tankers, reefer, vehicle carriers, and others.

Appendix A

Trade flows through the SLOCs

Crude oil accounted for 58 percent of the interregional cargo tonnage flowing through the Straits of Malacca in 1993 (table 21). Most came from the Arab Gulf and went to Japan, with Southeast Asia as a secondary source and the Newly Industrial Economies as the number two destination. This pattern was essentially repeated on the SLOCs passing the Spratlys (table 22). However, crude oil was a small percentage of the value of cargoes on these two SLOCs.

Finished goods, including autos, machinery, and consumer products, accounted for over 60 percent of the value of cargoes passing through Malacca and 65 percent of cargoes passing by the Spratlys. High-volume, low-value raw material inputs dominate the cargo volume totals. Finished products dominate the dollar values of the trade with Europe. The Far East dominates the dollar value of exports; Japan is the main source.

Three-quarters of the tonnage passing through Lombok was iron ore or coal in 1993 (table 23). This low-value bulk accounted for only 8 percent of the value of interregional cargoes passing through Lombok. About 94 percent of Lombok tonnage came from Australia. Of this tonnage, about half went to Japan, and 20 percent to the NIEs. The Sunda Strait was by far the least travelled strait, and most tonnage flows there were coal (table 24).

Liquid bulk moves east from the Arab Gulf to Malacca, then north to Japan and the NIEs. Dry bulk is dominated by Australian shipments going north via Lombok, supplemented by cargoes from India and other sources. These flows are "one-way."

Figure 19 shows a map of trade flows by value in manufactured goods. Note that these flows are generally "two-way" in nature. The next map (figure 20) shows the pattern of cellular (container) vessel movements, which mirror the flows of their main cargo, manufactured items.

Table 21. Interregional cargo flows via the Straits of Malacca, 1993[a]

	Volume (millions of tons)	Value (billions $US)
Commodity		
Coal and coke	15.0	0.7
Consum/elect./other	9.5	149.4
Crude oil	309.9	40.1
Dry bulk	14.3	3.1
Food/ag./wood	38.6	29.0
Industrial goods	13.8	46.2
Iron ore	31.6	0.9
Metal and machinery	29.9	98.7
Pet. products and chem.	72.2	23.4
Total	534.8	391.6
Destination region		
Africa	1.8	4.9
Arab Gulf	5.2	12.3
Asia NIEs	123.3	61.7
Australia	6.3	10.8
Canada	0.1	0.0
China	6.7	9.1
Europe and Med	40.1	156.6
Indian - SC	9.3	8.1
Japan	240.1	70.4
S. America	0.9	5.3
S.E. Asia	99.6	49.6
U.S.	1.5	2.7
Total	534.8	391.6
Source region		
Africa	8.1	2.7
Arab Gulf	334.6	46.6
Asia NIEs	12.7	57.9
Australia	12.9	6.0
Canada	2.0	0.3
Caribbean	0.1	0.0
China	5.4	9.1
Europe and Med	45.4	109.2
Indian - SC	26.8	6.8
Japan	12.2	99.6
S. America	8.2	0.3
S.E. Asia	62.0	47.5
U.S.	4.4	5.5
Total	534.8	391.6

a. Estimates include only interregional maritime shipments.

Appendix A

Table 22. Interregional cargo flows via Spratly Island SLOCs, 1993[a]

	Volume (millions of tons)	Value (billions $US)
Commodity		
Coal and coke	25.0	1.1
Consum/elect./other	11.9	184.9
Crude oil	256.7	34.3
Dry bulk	24.8	4.1
Food/ag./wood	50.9	38.5
Industrial goods	17.8	53.1
Iron ore	33.9	1.0
Metal and machinery	41.3	120.8
Pet. products and chem.	113.4	31.9
Total	575.7	469.6
Destination region		
Africa	2.0	5.6
Arab Gulf	6.1	15.8
Asia NIEs	179.0	83.1
Australia	1.3	8.1
Canada	0.3	0.1
China	7.0	9.1
Europe and Med	20.8	134.9
Indian - SC	5.4	7.4
Japan	305.2	95.8
S. America	0.9	5.3
S.E. Asia	41.0	79.4
U.S.	6.7	25.0
Total	575.7	469.6
Source region		
Africa	27.9	4.9
Arab Gulf	258.3	37.5
Asia NIEs	24.6	73.8
Australia	1.0	0.3
Canada	2.2	0.3
Caribbean	0.1	0.0
China	8.7	19.5
Europe and Med	31.6	78.8
Indian - SC	26.4	6.4
Japan	31.9	150.0
S. America	11.5	2.1
S.E. Asia	140.8	80.9
U.S.	10.8	15.1
Total	575.7	469.6

a. Estimates include only interregional maritime shipments.

Table 23. Interregional cargo flows via the Strait of Lombok, 1993[a]

	Volume (millions of tons)	Value (billions $US)
Commodity		
Coal and coke	35.4	1.5
Consum/elect./other	1.6	11.7
Crude oil	5.5	0.8
Dry bulk	6.1	0.5
Food/ag./wood	6.7	4.7
Industrial goods	1.9	5.0
Iron ore	68.4	1.6
Metal and machinery	4.2	11.2
Pet. products and chem.	10.0	2.3
Total	139.8	39.2
Destination region		
Arab Gulf	0.9	0.6
Asia NIEs	27.8	1.9
Australia	9.1	22.5
China	15.8	1.5
Europe and Med	1.6	1.3
Indian - SC	4.1	0.7
Japan	69.7	5.7
S.E. Asia	10.7	4.9
Total	139.8	39.2
Source region		
Africa	0.2	0.1
Arab Gulf	0.8	0.2
Asia NIEs	0.9	3.9
Australia	130.7	16.7
Canada	0.1	0.0
China	0.4	0.9
Europe and Med	1.0	6.1
Indian - SC	0.0	0.1
Japan	3.0	8.9
S.E. Asia	2.6	2.2
U.S.	0.1	0.1
Total	139.8	39.2

a. Estimates include only interregional maritime shipments.

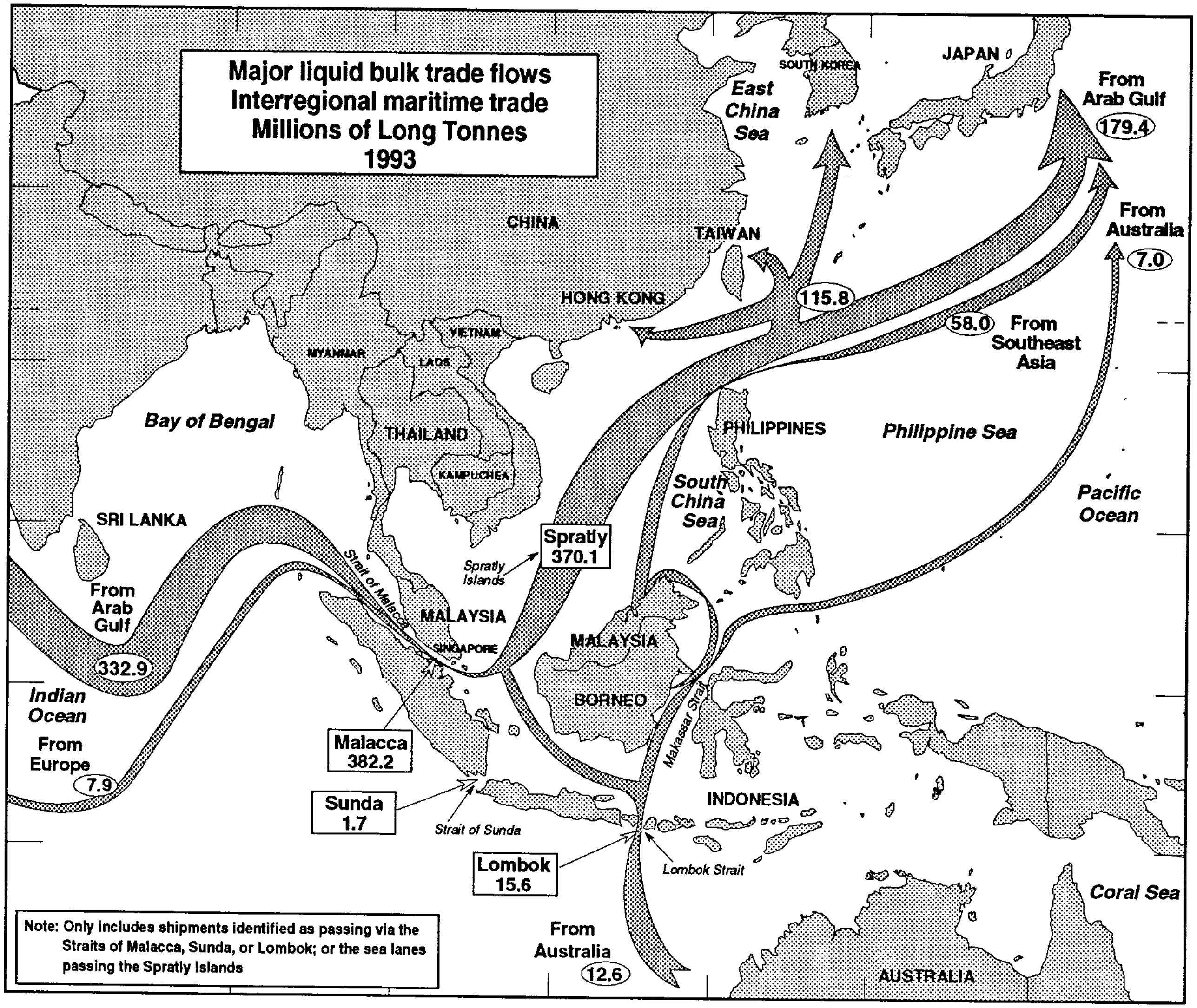
Appendix A

Table 24. Interregional cargo flows via the Strait of Sunda[a]

	Volume (millions of tons)	Value (billions $US)
Commodity		
Coal and coke	11.4	0.5
Consum/elect./other	0.0	0.2
Crude oil	1.1	0.1
Dry bulk	1.6	0.2
Food/ag./wood	0.9	0.6
Industrial goods	0.2	0.6
Iron ore	3.8	0.1
Metal and machinery	1.8	1.4
Pet. products and chem.	0.6	0.2
Total	21.5	3.9
Destination region		
Africa	0.1	0.5
Asia NIEs	10.7	1.0
China	0.0	0.0
Europe and Med	0.2	0.1
Indian - SC	0.0	0.0
Japan	8.9	0.9
S.E. Asia	1.6	1.4
Total	21.5	3.9
Source region		
Africa	18.1	1.6
Arab Gulf	0.2	0.0
Asia NIEs	0.1	0.1
Australia	0.0	0.0
Europe and Med	1.6	1.4
Japan	0.1	0.4
S.E. Asia	1.5	0.3
Total	21.5	3.9

a. Estimates include only interregional maritime shipments.

Figure 17. Major liquid bulk trade flows interregional maritime trade



Appendix A

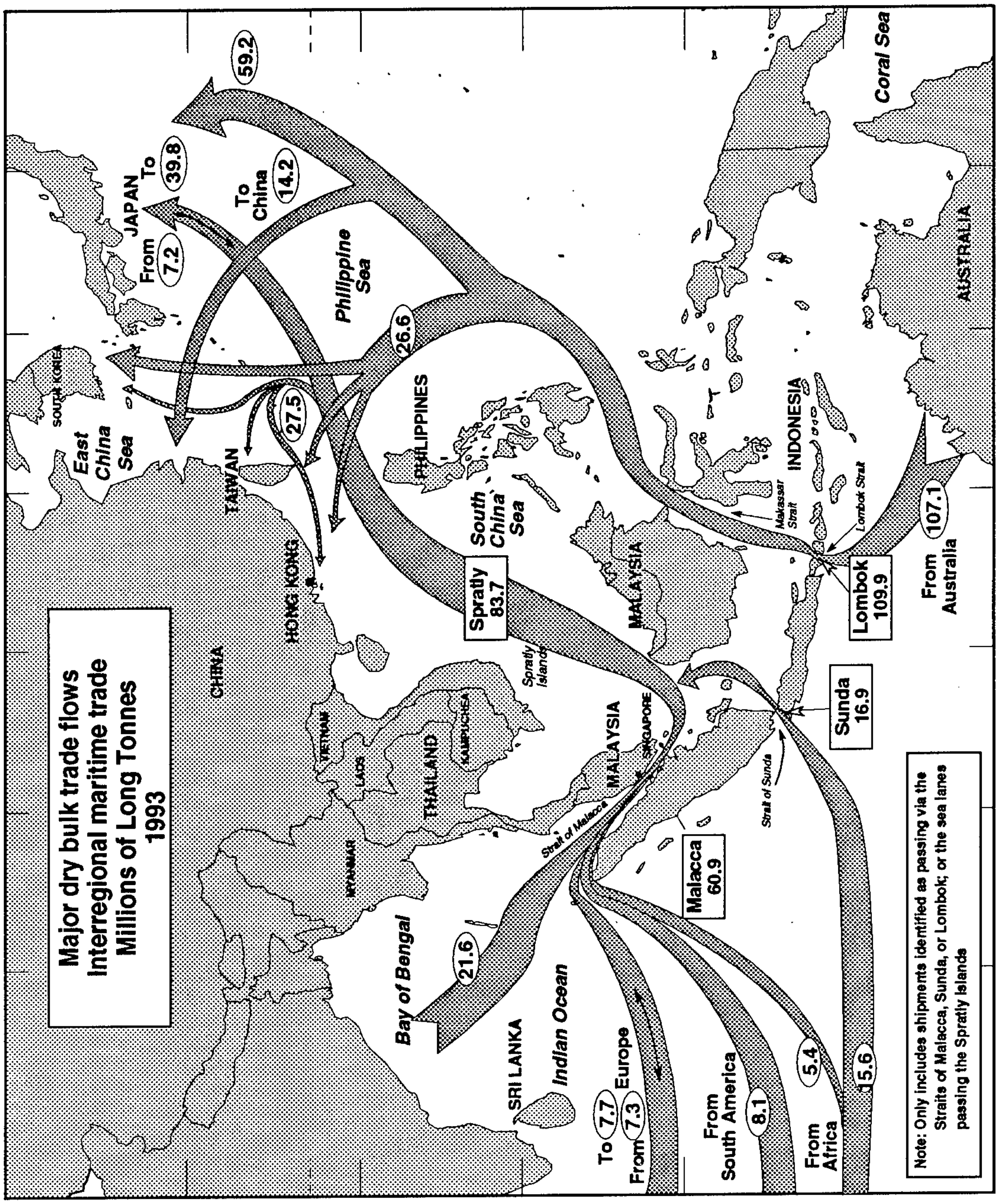


Figure 18. Major dry bulk trade flows interregional maritime trade

Figure 19. Major manufactured goods trade flows interregional maritime trade

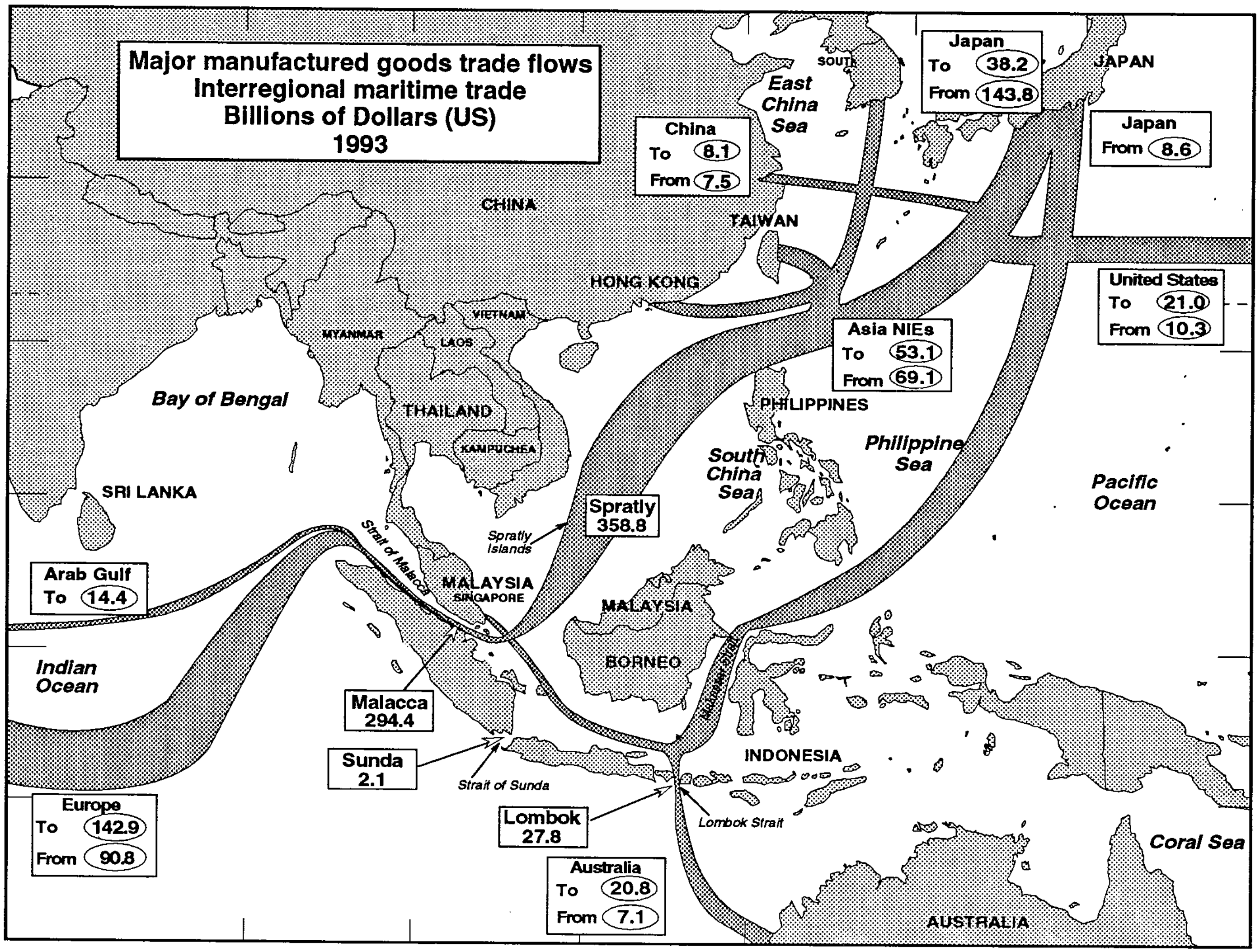
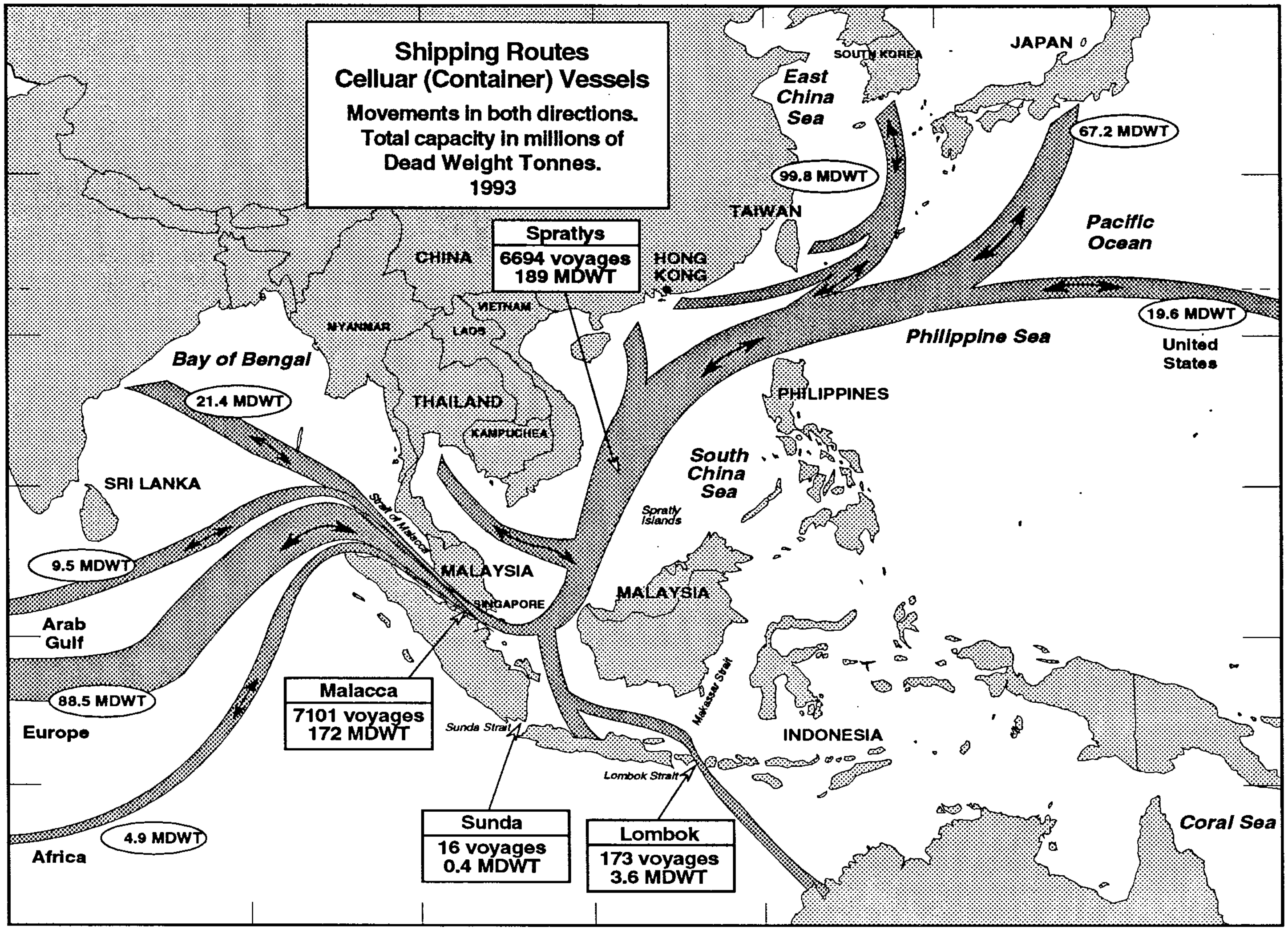


Figure 20. Shipping routes cellular (container) vessels



Trade dependence on the strategic SLOCs

Tables 25 through 29 show the tonnage and values of imports and exports passing through the four study chokepoints for selected economies. Also shown are cargoes passing through the SLOCs as a percentage of total imports and exports. Tables 6 and 7 in chapter 2 summarize these tables.

Table 25. Japanese trade via Southeast Asian SLOCs, 1993

Exports				Imports		
Million tons	Billion dollars	Percentage, export value	Southeast Asian SLOCs	Percentage, import value	Billion dollars	Million tons
12.2	99.6	27.5	Malacca	29.1	70.4	240.1
0.1	0.4	0.1	Sunda	0.4	0.9	8.9
3.0	8.9	2.5	Lombok	2.3	5.7	69.7
31.9	150.0	41.4	Spratlys	39.7	95.8	305.2
33.6	153.4	42.4	All Four	42.0	101.5	385.0

Table 26. Asian NIE trade via Southeast Asian SLOCs, 1993

Exports				Imports		
Million tons	Billion dollars	Percentage, export value	Southeast Asian SLOCs	Percentage, import value	Billion dollars	Million tons
12.7	57.9	19.2	Malacca	20.6	61.7	123.3
0.1	0.1	0.0	Sunda	0.3	1.0	10.7
0.9	3.9	1.3	Lombok	0.6	1.9	27.8
24.6	73.8	24.4	Spratlys	27.7	83.1	179.0
24.7	77.7	25.7	All Four	28.3	84.9	199.8

Table 27. Australian trade via Southeast Asian SLOCs, 1993

Exports				Imports		
Million tons	Billion dollars	Percentage, export value	Southeast Asian SLOCs	Percentage, import value	Billion dollars	Million tons
12.9	6.0	14.1	Malacca	23.7	10.8	6.3
0.0	0.0	0.0	Sunda	0.0	0.0	0.0
130.7	16.7	39.0	Lombok	49.4	22.5	9.1
1.0	0.3	0.6	Spratlys	17.8	8.1	1.3
133.6	16.9	39.5	All Four	52.8	24.0	10.2

Appendix A

Table 28. Chinese trade via Southeast Asian SLOCs, 1993 (PRC)

Exports				Imports		
Million tons	Billion dollars	Percentage, export value	Southeast Asian SLOCs	Percentage, import value	Billion dollars	Million tons
5.4	9.1	10.0	Malacca	8.8	9.1	6.7
0.0	0.0	0.0	Sunda	0.0	0.0	0.0
0.4	0.9	1.0	Lombok	1.5	1.5	15.8
8.7	19.5	21.4	Spratlys	8.9	9.1	7.0
8.9	19.8	21.8	All Four	10.3	10.6	23.0

Table 29. U.S. trade via Southeast Asian SLOCs, 1993

Exports				Imports		
Million tons	Billion dollars	Percentage, export value	Southeast Asian SLOCs	Percentage, import value	Billion dollars	Million tons
4.4	5.5	1.2	Malacca	0.4	2.7	1.5
0.0	0.0	0.0	Sunda	0.0	0.0	0.0
0.1	0.1	0.0	Lombok	0.0	0.0	0.0
10.8	15.1	3.3	Spratlys	4.1	25.0	6.7
11.1	15.2	3.3	All Four	4.5	27.3	9.5

Who owns the ships in the SLOCs?

Japanese interests owned 27.6 percent of the tonnage passing through the Malacca Straits in 1993, four times more than any other nation (table 30). Greece was second with 6.5 percent, and the United States was third with 6.2 percent of tonnage. The rest of the top ten owning nations are divided between maritime nations, such as the UK and Norway, and Asian nations, such as Singapore and Korea. The majority of owners for large states (Japan, Greece, United States, and most others) fly flags of convenience. Norway, Taiwan, and Malaysia are exceptions. This pattern is essentially repeated for the SLOCs passing the Spratlys (table 31).

Indonesian interests own about a fifth of the tonnage passing through the Sunda Strait, accounting for over a third of the transits (table 32). Japan is second and Hong Kong is third in Sunda. Japanese interests owned by far the largest share of shipping transiting Lombok (table 33).

Table 30. Use of flags of convenience (1993) by owner via Malacca (where ownership capacity > 35 MDWT)

Nationality of vessel owner	MDWT Capacity	MDWT Voyages	Percentage of fleet flagged out[a] Capacity	Percentage of fleet flagged out[a] Voyages
Japan	432	7,146	62	78
Greece	102	2,445	67	71
United States	97	1,177	77	64
Great Britain	90	1,218	91	89
Singapore	88	5,277	50	40
Norway	68	1,442	32	37
Korea (South)	66	949	67	45
Hong Kong	63	1,618	85	89
Bermuda	40	202	100	100
Denmark	39	1,062	56	47
Taiwan ROC	39	1,266	22	32
Malaysia	36	3,097	3	2

a. When the nationality of ownership does not equal the nationality of registry, the vessel is said to be "flagged out."

Table 31. Use of flags of convenience (1993) by owner via Spratlys (where ownership capacity > 25 MDWT)

Nationality of vessel owner	MDWT Capacity	MDWT Voyages	Percentage of fleet flagged out[a] Capacity	Percentage of fleet flagged out[a] Voyages
Japan	471	8,952	62	79
Greece	90	2,316	65	71
Great Britain	79	1,253	90	89
Hong Kong	72	2,114	80	90
Korea (South)	70	1,234	64	40
United States	70	1,074	73	64
Singapore	67	2,295	49	39
Norway	62	1,161	33	34
Taiwan ROC	53	2,130	31	47
Denmark	51	1,208	45	43
China PRC	43	2,096	15	14
Bermuda	32	206	100	100

a. When the nationality of ownership does not equal the nationality of registry, the vessel is said to be "flagged out."

Appendix A

Table 32. Use of flags of convenience (1993) by owner via Sunda (where ownership capacity > 3 MDWT)

Nationality of vessel owner	MDWT Capacity	MDWT Voyages	Percentage of fleet flagged out[a] Capacity	Percentage of fleet flagged out[a] Voyages
Indonesia	22	1,313	50	28
Japan	15	495	72	90
Hong Kong	10	143	63	76
Greece	8	218	57	67
Taiwan ROC	6	102	28	51
Korea (South)	6	75	63	75
Singapore	6	303	67	44
Great Britain	5	84	100	100
United States	3	54	97	94
Norway	3	68	45	44

a. When the nationality of ownership does not equal the nationality of registry, the vessel is said to be "flagged out."

Table 33. Use of flags of convenience (1993) by owner via Lombok (where ownership capacity > 5 MDWT)

Nationality of vessel owner	MDWT Capacity	MDWT Voyages	Percentage of fleet flagged out[a] Capacity	Percentage of fleet flagged out[a] Voyages
Japan	114	1,049	30	54
Korea (South)	40	239	53	52
China PRC	25	519	8	4
Taiwan ROC	18	177	15	32
Hong Kong	17	291	52	70
Greece	12	258	36	39
Australia	12	139	19	23
Norway	8	135	21	19
Great Britain	7	123	100	99
United States	7	98	99	98

a. When the nationality of ownership does not equal the nationality of registry, the vessel is said to be "flagged out."

The pattern is overwhelming: most vessels on these routes are "flagged out," flying flags of convenience. In fact, for only a few countries (such as Japan and Singapore) is there even a correlation of flags, ownership, and trade routes. For only a few Asian countries do owners typically fly their national flag; examples are China, Taiwan, and Malaysia. Norway and Denmark have international registries—a sort of "national flag of convenience." Some of the owning interests are in nations with maritime traditions, such as Greece, Norway, Denmark, and Britain. These countries supply shipping services to the world, and otherwise have few direct economic links with Southeast Asia.

Flags of vessel registry in Southeast Asian SLOCs

Table 34 shows total tonnage and transits through the Straits of Malacca by flag of registry, for common flags. The percentage of traffic owned by nationals foreign to the vessel's flag is also shown. The first four places for Malacca and Spratlys are the same: Panama, Liberia, Japan, and Singapore. Greece and Bahamas occupy slots five and six; Cyprus and Norway occupy slots seven and eight. The lists are similar (table 35).

Some flags are purely flags of convenience: Panama, Liberia, and Bahamas. Some are mainly for convenience, or, perhaps more accurately, they also shelter the company of ownership: Cyprus and Malta. A few flags have many foreigners as well as nationals owning vessels: Singapore and Greece. Many nations have few foreigners flying their flag: Japan, Norway, Taiwan, China, and the United States. Half or more of the traffic in these SLOCs fly flags of convenience. See tables 36 and 37 for details on Sunda and Lombok.

Appendix A

Table 34. Foreign ownership (1993) by vessel registry (flag) via Malacca (where flag capacity > 19 MDWT)

Nationality of flag	MDWT Capacity	MDWT Voyages	Percentage of fleet foreign owned Capacity	Percentage of fleet foreign owned Voyages
Panama	351	7,777	100	100
Liberia	228	3,382	100	100
Japan	176	1,653	7	6
Singapore	101	3,930	56	19
Bahamas	64	1,263	100	99
Greece	64	1,030	47	30
Cyprus	60	1,551	83	83
Norway (NIS)	50	985	8	8
Malaysia	41	4,012	15	24
Taiwan ROC	31	884	4	3
China PRC	30	1,406	5	1
Malta	26	870	97	97
United States	25	455	8	6
Korea (South)	24	590	10	11

Table 35. Foreign ownership (1993) by vessel registry (flag) via Spratlys (where flag capacity > 19 MDWT)

Nationality of flag	MDWT Capacity	MDWT Voyages	Percentage of fleet foreign owned Capacity	Percentage of fleet foreign owned Voyages
Panama	363	9,407	100	99
Liberia	208	3,615	100	100
Japan	192	2,017	8	7
Singapore	88	2,117	61	34
Greece	57	955	45	28
Bahamas	51	1,039	100	100
Cyprus	50	1,417	91	86
Norway (NIS)	44	834	8	9
Taiwan ROC	40	1,178	8	3
China PRC	37	1,829	2	1
Korea (South)	28	840	10	12
Denmark (DIS)	27	671	3	3
Malaysia	23	669	6	10
Hong Kong	23	314	38	33
Malta	21	619	95	95
United States	20	396	3	2

Table 36. Foreign ownership (1993) by vessel registry (flag) via Sunda (where flag capacity > 3 MDWT)

Nationality of flag	MDWT Capacity	MDWT Voyages	Percentage of fleet foreign owned Capacity	Percentage of fleet foreign owned Voyages
Panama	25	868	100	100
Indonesia	12	1,009	4	7
Liberia	9	242	100	100
Cyprus	7	169	93	94
Hong Kong	6	53	40	34
Taiwan ROC	6	62	30	19
Singapore	6	245	68	30
Greece	5	104	32	30
Japan	4	49	0	0
Bahamas	4	110	100	100
Philippines	4	68	83	78

Table 37. Foreign ownership (1993) by vessel registry (flag) via Lombok (where flag capacity > 4 MDWT)

Nationality of flag	MDWT Capacity	MDWT Voyages	Percentage of fleet foreign owned Capacity	Percentage of fleet foreign owned Voyages
Japan	80	486	0	1
Panama	44	663	100	100
Liberia	27	361	100	99
China PRC	23	497	0	0
Korea (South)	19	117	0	3
Taiwan ROC	16	127	7	6
Greece	11	219	32	28
Philippines	11	225	62	75
Hong Kong	11	130	25	34
Australia	10	118	5	9
Singapore	6	115	76	67
Norway (NIS)	5	110	7	9

Appendix B: Oil and safety in the Straits of Malacca

Maritime safety versus freedom of navigation

Merchant shipping issues about the Straits of Malacca are discussed in such forums as the International Maritime Organization (IMO). Malaysia and Indonesia consistently take positions emphasizing maritime safety. One factor is the environment. As littoral states, they possess sensitive mangrove swamps and aquaculture operations, such as shrimp farms along their shorelines, as well as coastal fisheries. They are quite likely to suffer from environmental and economic damage in the event of such accidents as oil spills.

One consequence is that these two nations have long advocated relatively large keel-to-bottom separations in shipping channels, when discussing maritime safety guidelines. Their diplomats argue that ship operators should be required to maintain a big margin of safety for vessel draft when transiting the straits. Because the straits are international waterways, the littoral states have no regulatory authority over foreign shipping within Malacca. International shipping enjoys freedom of passage through Malacca under the Law of the Sea, even though the Straits are almost entirely within the littoral states' territorial waters.

Singapore tends to favor the interests of ship owners to a greater extent than its neighbors. Singapore is more dependent than its neighbors on world shipping via the straits, for entrepôt trade, its refining industry, and profits from serving as an operational base for shipping. Singapore also has less to lose than Malaysia and Indonesia from an environmental perspective.

Malaysia and Indonesia advocate the use of the alternate route east of Bali and Borneo via the Straits of Lombok and Makassar for laden supertankers. While ship owners are quite discreet about this issue, a finding of this study is that very few, if any, follow this advice. For the main oil route, Arab Gulf to North Asia, almost all supertankers transit via the Straits of Malacca. The route via Lombok is 15 percent longer than the route via Malacca, which is the shortest available of all the alternatives for supertankers.

Furthermore, vessels plying Malacca can use the facilities of Singapore, a significant logistical and operational advantage. Westbound tankers in ballast have plenty of room under their keels to spare. At least three laden eastbound supertankers per day enter the Straits from the west, full of oil. Quite a few of these draw so much water that they test the draft limitations of the channel.

The safety problem is compounded by the lack of navigational aids along the channel and heavy volumes of shipping. The two littoral states that own most of the waterways' coastline, Malaysia and Indonesia, benefit far less from the international through-traffic than Singapore, which has jurisdiction over a relatively small portion of Malacca. Furthermore, there is the responsibility for disaster response to consider.

It has been suggested that the two littoral states levy a toll on shipping to finance emergency response and better navigation aids. This proposal has met with an unenthusiastic response from the international maritime community. Such schemes violate the international legal status of the straits, and could open the door for more rigorous assertions of sovereignty. Efforts to stimulate voluntary contributions from other nations for these facilities, especially from Japan, have not yet garnered the required financial resources.

In 1994, the Malaysian government established the Malaysian Institute for Maritime Affairs (MIMA) to coordinate maritime policy and promote Malaysian interests. In 1995, Malaysia proposed a Vessel Traffic System (VTS), featuring local area radar, traffic advisories, and voluntary coordination of shipping in the channel (somewhat similar to air traffic control). Malaysia also presented a scheme before the IMO for redefining the shipping lanes and improving the navaids. This latest was reportedly supported by Japan, implying financial support in future for waterway improvements.

MIMA has indicated interest in determining what shipping passes through the straits, including such details as registration, origin, and destination. It may be that Malaysia intends to use the results of a Malacca Straits maritime traffic survey to identify nations that benefit economically from the straits, in order to solicit financial support from them. A user's fee or toll levied directly on shipping would appear to violate international law, due to the straits' status as international waterways. A scheme of voluntary contributions from foreign governments based on use of the straits does not violate the law, but requires international cooperation. This is a sophisticated idea. In the future, MIMA may generate detailed estimates of Malacca Straits vessel traffic.

Draft restrictions in the Straits of Malacca

The channel depth estimate used by one major oil company for tankers transiting the Straits of Malacca ranges from 21.1 to 22.9 meters, depending on the tides and the time of year. This is representative; the maximum depth typically quoted is 22 meters (12 fathoms, or 72 feet). Captains often time their entry into the channel to take maximum advantage of the tides, arriving at One Fathom Bank at high water. Another oil shipper, also a major oil company, reports that its policy requires 10-percent clearance between keel and bottom, or about 2 meters' clearance. This rule implies that its vessels operate drawing a maximum of about 20 meters (65.6 feet) in the Malacca channel.

Some ship operators believe that a meter of clearance is sufficient keel-to-bottom separation, for mean low water. In contrast, "official" recommendations over the years range from 2.5 (Singapore) to as much as 4.5 (Malaysia) meters of separation. The IMO and Malaysia currently recommend 3.5 meters of separation. These larger officially recommended margins take into account allowances for wave action, human error, and "squat." Squat is the tendency for the bow to rise and stern to settle, so the ship draws more water when under way at speed. Some members of the shipping community point out that stable slow-moving tankers do not squat and rarely roll, that there are few (if any) heavy seas in the channel, and that the channel is very well charted.

Do the draft restrictions matter to supertanker operators?

Next, we'll look at the drafts of supertankers observed in the Straits of Malacca as compared to the depth of the navigable channel. The result: the discussion about depth limitations and margins of safety does matter, and it affects supertanker operations.

Referring to table 38, the two largest sizes of supertankers operating in the region are affected by the Straits of Malacca draft constraint. Larger vessels within the range of 160,000 to 250,000 deadweight tons (DWT) are definitely testing the "officially" recommended limit of 18.5 meters when fully laden, although many squeeze in under a limit of 20 meters. Most tankers of the largest size observed in the region, over a quarter million DWT, operate well in excess of any official guideline when laden. Many of the larger supertankers light load, taking cargoes of less than maximum size, to reduce their draft when they sail through the straits. When returning in ballast from their port(s) of discharge, they draw much less water because they are not carrying cargo.

Most operators of both these classes of oil tanker are motivated by economic considerations to disregard the official guidelines and use their own judgment. Like the high

Table 38. Supertanker design drafts (meters)

	VLCC size	
	160–250K DWT	Greater than 250K DWT[a]
Average draft	19.4	21.2
Standard deviation	1.01	1.36
Maximum	21.4	28.6
Minimum	15.5	18.4

a. Note: Excludes ULCCS > 320K DWT.

seas, the Straits of Malacca are international waterways, and IMO recommendations and Malaysian regulations cannot be enforced. Skippers are free to load as much oil as they please from a legal point of view. To transport their cargoes efficiently, the supertankers need to be as full as possible. However, the more oil they carry, the more water they draw, and the more likely they are to run aground. It appears that most of these supertankers would forgo significant revenues if they loaded to 18.5 meters rather than 20 plus meters of draft (as an example).

How much supertanker traffic transits Malacca?

How many supertankers sail through Malacca, and how much oil do they carry? The answer is many ships—and lots of oil. First, we'll look at the ships affected by the draft restriction, and then at the cargoes they carry.

Table 39 shows that over half a billion deadweight tons of supertanker capacity passed through the Straits of Malacca in 1993, nearly 2,300 voyages in all. Significantly, most of this traffic is the larger supertankers, those most affected by the channel depth constraint. With few exceptions, eastbound supertankers are laden with oil. Westbound supertankers are in ballast, returning empty to the source of supply. Over 1,100 laden voyages and nearly 300 million DWT of laden vessel capacity throughput are affected. A significant percentage of these vessel operators face a close judgment call about draft restrictions. Loading too deep may ultimately contribute to an accident; loading too light reduces profits. The tradeoff between operating cost efficiency and safety matters for many supertanker voyages.

Most surprising is that there have been so few groundings and collisions over the years, given the amount of deep draft traffic going through the Straits of Malacca. The traffic density combined with the channel depth can create a difficult situation in the narrow channel. A supertanker finding itself on a collision course with another ship may

Table 39. Supertankers transiting the Straits of Malacca, 1993

Supertanker size	Vessel capacity (MWDT)	Vessel transits[a]
160–250K DWT:		
Westbound (ballast)	105.6	452
Eastbound (laden)	105.9	453
Over 250K DWT:		
Westbound (ballast)	179.8	669
Eastbound (laden)	182.7	684
Total supertankers:	574.0	2,258

a. Note: Includes only interregional voyages, excludes lightering.

face a Hobbesian choice. The watch officer may be forced to choose between the risk of a collision in the channel and the risk of running aground by leaving the channel. Supertankers may take 10 miles to stop, and they have little control at very slow speeds due to loss of steerage way.

Table 40 provides statistics on interregional oil shipments carried on VLCCs through the Straits of Malacca in 1993, by size of supertanker. Over a quarter of a billion tons of oil worth over $35 billion traveled on vessels sensitive to the draft restrictions of the straits. By comparison, world crude oil shipments by sea in 1992 were slightly over 1.3 billion tons. About a fifth of all crude oil moving by sea goes through the Straits of Malacca in a supertanker.

Table 40. Cargoes[a] carried by supertankers through the Malacca Straits, 1993 (eastbound crude oil by volume and value)

Supertanker size	Oil volume transported (MWDT)	Oil value transported (billion dollars)
160–250K DWT	102.6	13.6
Over 250K DWT	168.6	21.7
Oil via Malacca in supertankers, 1993	271.2	35.2

a. Note: Includes only interregional shipments.

Appendix B

Economic impact of rerouting supertankers

The channel depth of the Malacca Strait can constrain supertanker transits from an operational point of view. What if supertankers were excluded for some reason from the Straits of Malacca? How much would it cost, and who would pay? Over half the oil transiting the Straits of Malacca in supertankers in 1993 was bound for Japan from the Arab Gulf. That oil would cost about 15.2 percent more to ship on the laden leg (table 41). The total cost increase for the entire voyage would be about half that, if the return ballast leg could still use Malacca. The rest is split between Singapore and the Asian Newly Industrialized Economies (NIEs) of South Korea, Taiwan, and Hong Kong. Singapore receives large amounts of its interregional imports by supertanker, and the longer trip south around Sumatra to the approach from the east generates a large detour. These observations underscore the divergence of Singapore's economic interests from the safety and environmental concerns of Malaysia and Indonesia. A lot of oil faces a large detour, if denied access to the Straits of Malacca.

Table 41. Oil shipments carried by VLCC by route via the Straits of Malacca

Route	Distribution of volume of oil (%) 160,000 to 250,000 DWT	Distribution of volume of oil (%) Greater than 250,000 DWT	Voyage increase via Lombok (%)
Arab Gulf to Japan	24.8	30.0	15.2
Arab Gulf to Asian NIEs	8.0	14.9	22.3
Arab Gulf to Singapore[a]	4.8	17.0	49.7
Other	0.3	0.3	—

a. Note: Sunda might be a more realistic reroute. This is a "worst case" assumption for Singapore.

Table 42 presents estimates of the incremental cost of shipping laden supertankers via alternative routes other than the Straits of Malacca. The costs include extra fuel and operating costs en route for the detour, plus the costs of financing the capital cost of the vessel and the cargoes for a longer voyage. It is assumed that empty supertankers could return to the Gulf by the Straits of Malacca. The total extra cost in 1993 would have been $166 million. That is a lot of money to the vessel operators when one considers that it is divided up among 286 westbound supertankers on 1,136 laden transits. That's about $146,000 per voyage on average. However, these vessels are carrying a lot of oil. When the extra voyage costs are spread over the value of the cargoes, detours add less than 1 percent to the price of oil landed at the destination. So, a large cost in dollar terms to

the industry is a small cost to the affected economies. Representatives of one major oil company indicated that, to be commercially viable, vessels would have to carry 380,000 tons of oil to justify routing via Lombok. This company ships an average of 250,000 tons per voyage via Malacca. That is, for economies of scale in ship size to offset the longer distance, much larger ships would be required. However, oil ports in the primary destination, Japan, typically have draft limitations much like those of Malacca, so the larger vessels (including the even larger ULCCs) cannot be employed. Even for oil, there are not many deep-water facilities in East Asia.

Table 42. The incremental cost of rerouting oil shipments carried by supertankers via Lombok currently transiting via the Straits of Malacca[a]

Origin and destination	Shipping and holding cost increase ($ M)	Price increase (%)
Arab Gulf to Japan	78.9	0.4
Arab Gulf to Asian NIEs[b]	42.2	0.6
Arab Gulf to Singapore	44.5	0.6
Other	0.5	0.3

a. Note: Assumes the return ballast leg can transit via the Malacca Straits.
b. NIEs: South Korea, Taiwan, and Hong Kong.

Over 20 percent of the crude oil passing through the Straits of Malacca from the Gulf is bound for Southeast Asia, arriving at Singapore in large supertankers. Singapore is a major refining center, importing crude in large tankers and exporting product all over the region in smaller product tankers. Any policy or set of events that inhibited the use of supertankers in Malacca could increase voyage distances up to 49.7 percent if the alternative was Lombok. But the increase in price for Singapore-bound crude would be only 0.6 percent. More likely, they would reroute a much shorter distance via the Sunda Strait, if they rerouted at all. But, it is difficult to imagine that Singapore would easily accept such a constraint to one of its most important industries. Singapore has more economic reasons than any other nation to insist upon commercial freedom of navigation in the Straits of Malacca. The north Asian trading nations can always ship by Lombok, but Singapore has no realistic alternative to Malacca. And, Singapore profits from serving Malacca traffic to other nations.

An added attraction of the Malacca route over others for through-bound supertankers is operational convenience. The Port of Singapore offers a full range of facilities.

With low taxes, competitive prices, cheap bunker fuel, fast turnaround, and a minimum of regulations and restrictions, many large vessels call at Singapore for purely operational reasons. There is no other comparable port situated right next to the main route of the region. Singapore has a stake in serving international through traffic in Malacca, and a minimum of sensitive coastline exposed to possible pollution damage. It is not surprising that the government of Singapore exhibits much less support for proposed draft restrictions than its two neighbors.

Singapore

Table 43 shows the number of vessels arriving at Singapore port annually, over the 1985–1994 time period. Both the number of vessels calling and the tonnage arriving have nearly tripled in the last decade.

Table 43. Vessel arrivals at the Port of Singapore

Year	Number of vessels[a]	Millions of gross tons[b]
1985	36,531	272.0
1986	40,722	333.7
1987	42,560	352.4
1988	44,855	403.0
1989	49,107	436.7
1990	60,347	491.2
1991	70,345	536.6
1992	81,334	578.5
1993	92,655	623.8
1994	101,107	678.6

a. Includes regional ferried vessels over 75 gross tons.
b. Note that deadweight tons are a mass-based measurement, while gross tons are a volume-based measurement.

Singapore has established itself as a world shipping center. Singapore sells about 1.5 million tons of fuel per month to oceangoing vessels. Table 44 shows vessel calls by purpose at Singapore for the first quarter of 1994. Over half of the ships by tonnage are calling for operational reasons—well over half of the number of seagoing vessel arrivals. Many vessels either delivering or picking up cargo also take care of operational tasks while at port. Operational tasks include taking on fuel (bunkers), conducting ship repairs, and taking supplies aboard.

Table 44. Vessel calls by purpose, Port of Singapore, January–March 1994

Purpose	Number of vessels[a]	Percent of vessels	Gross registered tonnage (000)	Percent of tonnage
Single purpose	16,990	72	74,520	47
Cargo	6,183	26	32,228	20
Operational[b]	10,807	46	42,292	26
Multipurpose	6,749	28	85,728	53
Cargo and operational[b]	3,343	14	47,356	30
Operational[b]	3,406	14	38,355	24
Total, 1st quarter 1994	23,739	100	160,230	100

a. Includes all seagoing vessels in excess of 75 gross registered tons.
b. "Operational" includes bunker, supply, repairs, and other purposes.

Ready access to Singaporean facilities is vital for the smooth operation of merchant shipping in the South China Sea. At the same time, Singapore's economy depends heavily on the health of merchant shipping in the region.

Appendix C: Transportation economics

Transportation cost-benefit calculations were pioneered by the French economist Jacques Dupuis in the early 19th century. He intuitively understood many fundamental principles of modern economics. Indeed, some principles that are fundamental to his approach are still not fully appreciated by all economists. Dupuis clearly understood the basic neoclassical concept of producer and consumer welfare.

Dupuis also understood that many economic analyses misestimate or overestimate the economic costs or benefits of economic phenomena. For example, consider the case of social evaluation of transport project costs and benefits. Dupuis was adamant in his opinion that in most circumstances all economic benefits and costs to society can be measured fully within the transport sector, without reference to consumers, knock-on effects, "multipliers," and the like. This point is elegantly extended in the modern literature by such authors as Wisecarver (*Journal of Political Economy,* 1976). The impact felt on the transport side of, say, a traffic disruption can indeed be transmitted to consumers via higher prices. But, from a social point of view, the cost to society can be computed in full on the transport side, and to add together the cost to consumers and the cost to transporters is double accounting. So-called economic multipliers are often misused. Such double or multiple accounting is perhaps the most common conceptual error in applied cost-benefit analysis. For a good discussion of cost-benefit fundamentals, see *Project Evaluation* by Arnold Harberger (1972).

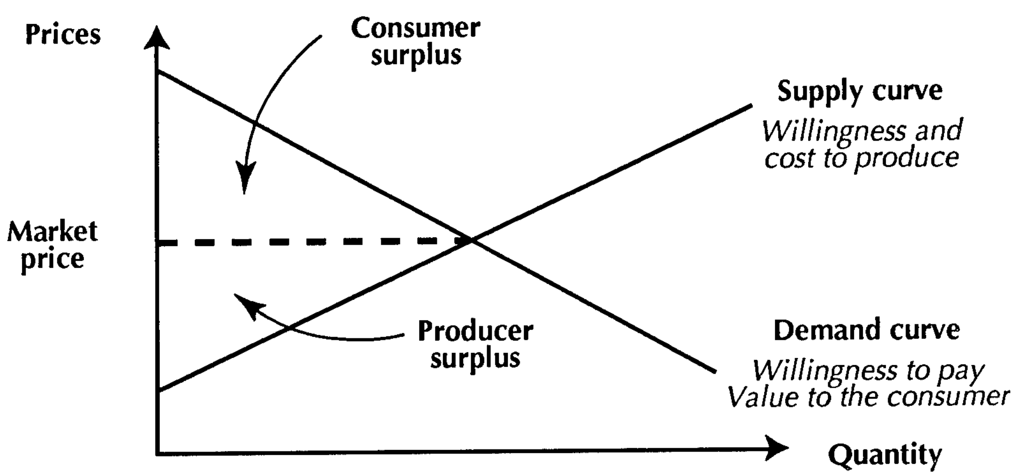
Suppose that we wished to build a public work, such as a canal, and wished to receive financial support from an international institution such as the a World Bank. There is a standard approach, an economic cost-benefit methodology, readily accepted by engineers and applied transportation economists. First identify, estimate, or count the traffic flow that would benefit from the public work in question. Next, estimate how much the users would benefit. That is, evaluate in dollar terms the benefits accrued by the traffic attributable to the project. Benefits might be shorter trips, or faster transit, or less wear and tear on equipment, or greater safety. Finally, sum the benefits per user over all users to compute the net benefits of the project.

We borrow from this methodology, and invert it. Vessels currently enjoy free transit on the high seas and the strategic international straits of the South China Sea and Lombok-Makassar. Suppose they were denied this transit, or were reluctant to sail these routes for whatever reason. We identify the actual vessels sailing these routes, what they are carrying, and their vessels' operating costs. If they must detour, we postulate the alternate route they might take. Then, we calculate how much extra it would cost to ship the cargoes by the alternate route. This represents the cost of a disruption of sea lines of communication that forces ships to detour. (To add in a "multiplier" for "disruptions to other sectors of the economy" would typically result in overstating the cost to society.)

Welfare loss: Maritime detour costs as a tax

Consider a traditional graph of supply and demand in a commodity market (see figure 21). At the quantity where the demander's price equals the supplier's price, there is equilibrium. "Consumer's surplus" is economic terminology for the area under the demand curve but above the market price, and is a measure of the benefit that consumers receive in this market. The gap between the market price and the demand function is the difference between what buyers would have been willing to pay, and what they did pay. "Producer's surplus" is the gap between the supply function and the market price. Of course, supply versus demand is always the primary function of market economies, and all other cost analyses are subordinate in world trade.

Figure 21. Consumer and produce surplus



Now, suppose an additional cost is imposed on this market, for example, extra transport costs, and that these costs had initially been negligible. These extra costs drive a wedge between buyer and seller, just as a tax does. Neither buyer nor seller benefits from the "tax," which is extracted from either the producer, the consumer, or both. That is, the costs imposed on the market reduce either consumer or producer surplus.

Suppose that the seller is very price sensitive, or price elastic in economic jargon. The quantity that the seller offers on the market varies a great deal depending on the market price. In an extremely competitive market, if manufacturers can cover their costs, they will supply as much as the market requires. Suppose that consumers are less price sensitive. In such a market, the consumer winds up paying the "tax." In the maritime transport example, if importers are less price sensitive than exporters, the importer-consumers will pay the detour costs.

Suppose the opposite, that sellers are not very price sensitive, but that buyers are. Buyers will react strongly to increases in market price, but sellers less so. In such cases, sellers will pay the tax. In our example, these are the exporters.

Regardless of who winds up ultimately paying the "tax," retailer or consumer, we can calculate the size of the burden imposed by forced detours on the world economy, and we know that the cost is paid by either importer or exporter. We are dealing with 40 categories of commodities traded between many nations. The problem of estimating literally hundreds of pairs of elasticities would only detract by adding ambiguity. The cost of the added transport burden is well approximated by calculating the number of tons diverted times the cost per ton of the diversion.

Who pays the detour costs?

The initial incidence of the scenario costs, be they for detours or lost trade, has little to do with who finally pays the costs in the long run. Unless caught unaware, vessel operators will pay little or none of the detour costs, and none of the port blockage costs. The extra costs of detours can be viewed as a type of tax levied on shipping by events, a "fee" extracted from the importer and/or exporter. Like a tax, the extra shipping cost of detours is external to the market, and has nothing to do with production costs. The detour costs are a "wedge," or differential, between the price received by the supplier and the price paid by the final purchaser. The vessel operator is just the "messenger" between the two principal parties to the transaction.

Once the industry has adjusted to the situation, the cost will be borne by the exporter or importer, or shared between the two. The shares borne by the two parties

to the transaction depend on the price elasticities of supply and of demand. The less price sensitive one of the parties is, the more of the tax-like cost they will pay.

In the very short run, before adjustment, cost incidence may be determined by how contracts are written between ship operators and shippers of cargoes. For example, if a shipper has chartered a vessel by the day, paying all costs, and the vessel must travel farther, the shipper may wind up paying the extra costs for that particular voyage. Alternately, if the vessel operator has contracted to take a cargo from one port to another for a flat fee, the operator may wind up paying any detour costs for that voyage.

For manufactured goods produced by competitive suppliers, it is typical to assume that the eventual consumer will pay the costs. With razor-thin profit margins due to competition, suppliers are assumed to be unable to absorb any additional costs. Like retail sales taxes in most instances, the cost is passed on to consumers, who eventually bear the detour costs in the form of higher prices for imports arriving by sea.

For bulk commodities that are inputs to manufacturing, suppliers often bear the brunt of transport costs of bringing their product to market. Consider coal or iron ore. A firm has sunk a large investment into opening up a mine; that money is already spent and is termed a nonrecoverable "sunk cost." As long as world prices exceed ongoing extraction costs, the firm will be motivated to produce and export. Industrial users of the product, on the other hand, are accessing the world market for a fungible commodity, and will buy from the cheapest source of supply. There is a limit imposed by supplier competition on any one firm's ability to pass on commodity price increases to industrial users.

For commodities, it is helpful to ignore the individual export-import trade links, and think of the international market as a large pool. Exporters sell into the pool at prevailing prices, while importers access commodities from the pool at prevailing prices. The exact identities of the importer and exporter on a specific trade link are of little real consequence. If Australian ore producers must send their exports on longer voyages to Japan for some reason, and if unaffected South American producers are ready to supply Japan at equivalent prices, then Australian producers must absorb the longer voyage costs in the form of lower supplier prices—or lose the business.

Maritime transport cost analysis

First, estimate the incremental costs of longer voyages. In economic jargon, these are the marginal costs of forced shipping detours on the high seas. Three cost factors are used as components of marginal cost:

- *Vessel operating costs.* The variable costs of operating a ship under way, including fuel, lubricant, crew wages, food, maintenance, insurance, administration, and the like. These vary from flag to flag, mainly because crew pay, safety regulations, and insurance rates vary by nationality of registration. Registry determines which nation's laws and regulations apply to the vessels. Fuel, lubricant, and some maintenance costs are determined by the distance traveled. However, most of these costs accrue on a daily basis when the ship is manned and ready to sail.
- *Cost of capital for vessels.* This is the cost of owning the vessel, also called "hull rental." It includes interest on outstanding loans, plus a provision for servicing the debt, plus a return on equity financing. Vessel age by type is taken into account to determine the value of the average vessel. This cost element is time related, calculated on a per diem basis.
- *Cargo holding cost.* This is the incremental cost of holding the cargoes during a longer voyage. This is the familiar "inventory holding cost" found in business literature. It includes the cost of capital for financing the cargoes, a function of interest rates and the value of the cargoes. Fortunately, our data include type and value of the trade flows, as well as tonnages. Holding costs include provisions for deterioration, "shrinkage," container rental if applicable, and miscellaneous storage costs of cargoes at sea.

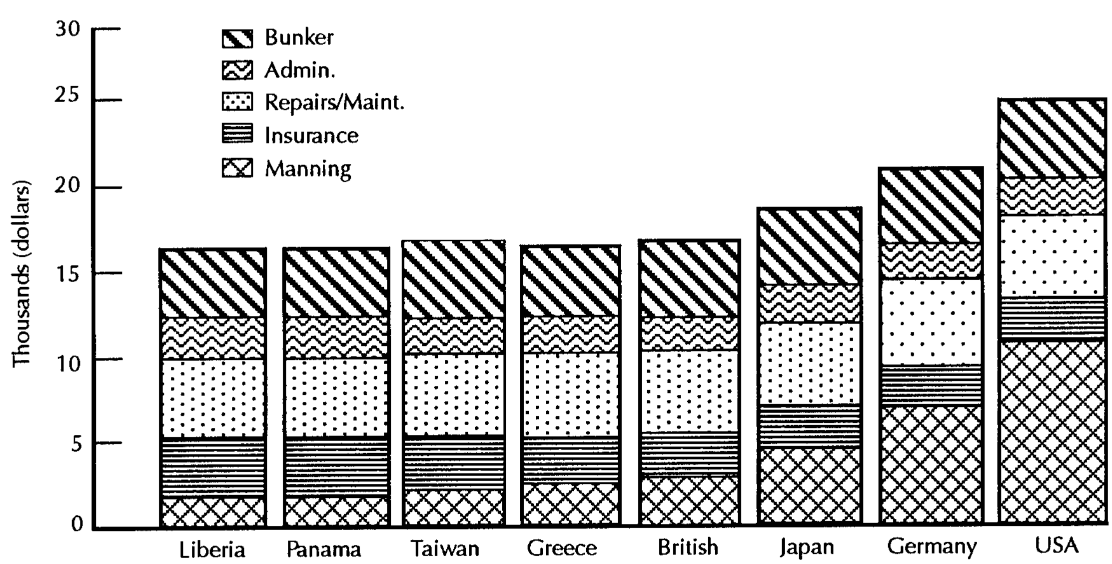
For each scenario, we counted up the number of ships forced to deviate and measured the extra distance traveled by each ship. Then we converted the distance calculation to extra ship days en route by reference to each vessel's "economic cruising speed," the speed at which ships operate most cost effectively. With our ship movement data, we could determine actual cruise speeds for each vessel type. Fuel consumption increases in proportion to the square of the speed increase over economic cruising speed. It is safe to assume that ship operators will typically not steam at faster speeds to offset the time lost due to longer voyages, in normal market conditions, unless freight rates happen to be very high.

The first two cost elements, operating costs and hull rental, are vessel related and can be calculated on a per-diem basis. We calculated the extra vessel costs per day, and

attributed them to cargoes that they carried. The extra vessel costs per ton of cargo took into account ballast versus laden legs and typical load factors (ships are typically less than completely full). The third cost element is cargo specific. Having computed the extra vessel costs per ton of cargo in transit, we added in the holding cost per ton of cargo. This entailed carrying over from the vessel side the extra days sailed by the cargo itself, as well as the extra vessel costs per day per ton of net utilized capacity. This level of precision would not have been possible without a detailed integrated database including both vessel and trade information.

Figure 22 shows daily vessel operating costs of supertankers for eight nationalities of registration, or flags. Not surprisingly, the cheapest operators are flags of convenience, Liberia and Panama, and next cheapest are Taiwan and Greece. European- and Japanese-flagged vessels are more expensive to operate. The most expensive to operate are vessels flying the Stars and Stripes, registered in the United States. American and Japanese ship owners have powerful competitive motivation to flag out, registering and operating their vessels under flags of convenience.

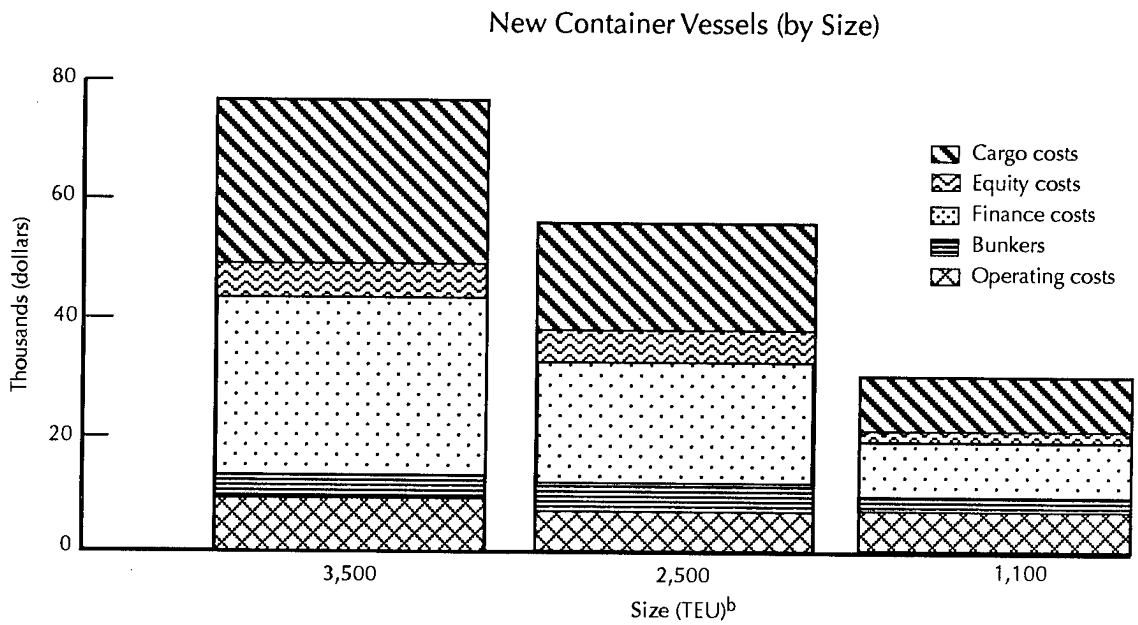
Figure 22. Daily operating costs by flag, 1994



Bunkers Includes Crew

Figure 23 shows the daily costs of voyaging extra distances by laden cellular (container) vessels, for various vessel sizes. Cellular capacity is measured in "Twenty-foot Equivalent Units," or TEUs, a measure of the number of containers it can carry. As one might expect, larger vessels cost more to operate, but are cheaper to operate per container of cargo. With very valuable cargoes, the most important cost element here is the holding costs of cargoes in shipment. So, these vessels steam quickly, averaging perhaps 19.5 knots as opposed to 12.5 knots for bulk carriers. These specially equipped vessels are expensive, so the next largest cost factor is the capital cost of the vessel. Operating costs are the least important cost item for this class of vessel.

Figure 23. Daily costs of a vessel in transit[a]

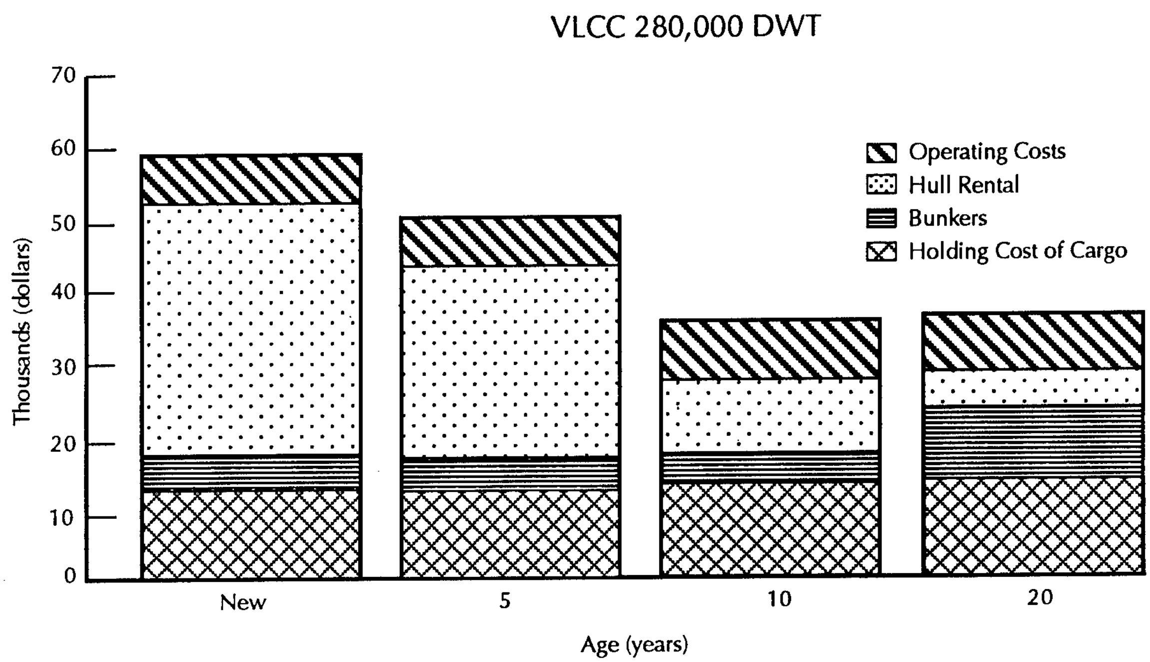


a. Excludes cost of equity.
b. "Twenty-foot Equivalent Unit," a measure of container size by volume.

Figure 24 shows costs the daily cost of voyaging extra distances by a loaded supertanker, for supertankers of various ages. Crude oil is less valuable per ton than the finished goods normally carried by cellular vessels. Here the cost of capital for the vessel is the most significant component of marginal cost, followed by operating costs. This figure shows that least costly (10 year old) vessels are cheaper to operate per day than newer vessels. The reduced cost of capital more than offsets the increased fuel burn for the older ships. Older vessels can earn money in markets in which newer vessels have trouble generating a sufficient rate of return on investment.

Appendix C

Figure 24. Shippers' daily transport costs[a]



a. Excludes cost of equity

Shipping economics and vessel design

The age of the tramp steamer that would carry any cargo any place is over. Merchant vessels now vary considerably by size and type. Modern merchant men are specially designed for the types of cargo that they carry, and for the kinds of routes that they serve. As one might expect, large vessels serve the long-haul routes, while smaller vessels typically serve shorter routes.

Economies of scale motivate vessel operators to ship large cargoes when practical. The larger the cargo, all else equal, the cheaper it is per cargo ton-mile to move it over the ocean while under way. The larger the vessel, the lower the ratio of wetted surface to total mass displaced. Less resistance must be overcome per deadweight ton to push larger vessels through the water. Fuel burn per cargo ton-mile is reduced. The larger the vessel, the greater the proportion of useful load (cargo plus fuel) per deadweight ton of vessel. Large vessels need crews little larger than small vessels, so large vessels are cheaper per cargo ton-mile to staff. Larger vessels can often load or discharge cargoes at faster rates than smaller ones, yielding economies in handling costs.

Offsetting the advantages of size are the draft restrictions of most ports. There are few natural deep-water ports in the world. The larger the vessel, the fewer ports it can visit fully laden with cargo. Light-loading large vessels may permit them to make port calls at relatively shallow harbors; however, light-loading fails to exploit the advantages of economies of scale of large vessels. Transshipping transoceanic cargoes from large to smaller vessels adds handling costs. The smaller a vessel, the more routes and ports it is physically capable of serving. A large vessel requires a big cargo to generate an adequate load factor, while a small vessel can easily be fully loaded.

A key vessel design factor is desired economic cruising speed. The faster a ship steams, the sooner its cargo reaches market, and the more ton-miles of service it can provide per day. But, the faster it steams, the higher its operating costs, especially for fuel. The rate of fuel consumption increases exponentially as a ship increases its rate of speed. Also, displacement vessels have a natural top speed determined in part by waterline length. However, one of the main economic considerations for merchant ships is the tradeoff between speed and fuel cost.

Another determinant for vessel design speed is the value and time sensitivity of the cargo. Low-value-per-ton cargoes do not cost much to finance while in transit, and shippers of such goods seek out the cheapest possible transport. So, bulk carriers typically steam at 12 or 13 knots. High-value cargoes cost much more to finance in transit, and shippers typically want to rush these goods to market. So, modern container vessels generally steam at about 19 knots. Refrigerated vessels generally also cruise at high speed in order to quickly deliver their perishable cargoes, primarily foodstuffs.

Supertankers and the South China Sea

The term "supertanker" is rarely used by the shipping industry, whereas the term "VLCC," or Very Large Crude Carrier, is much more common. VLCC typically refers to oil tankers greater than (say) 150,000 or 160,000 deadweight tons (DWT) up to 320,000 DWT. The term "deadweight tons" is a measure of the useful load of a vessel, and refers to the weight of fuel and cargo the tanker can carry measured in metric tons. The usual cargo-carrying capacity of a tanker is 95 percent of the DWT, with 5 percent reserved for fuel.

A typical supertanker often found on the Arab Gulf to Japan route is the Japanese *Cosmo Andromeda,* which is 238,500 DWT and 315 meters (1,035 feet) long overall. By comparison, the larger U. S. Navy nuclear aircraft carriers, such as the CVN 72 or 73 (CVN *Abraham Lincoln* or CVN *George Washington*), have flight decks that are 1,092 feet

long, and they displace only 102,000 tons. In other words, a typical medium-sized supertanker when empty displaces as much mass of water as some of the largest naval warships afloat, and more than three times as much when fully laden with crude oil.

The world's largest merchant vessel, the Norwegian *Jahre Viking*, is an Ultra Large Crude Carrier (ULCC), which carries 564,763 DWT and is 458 meters (1,502 feet) long. There are 14 ULCCs, normally defined as tankers exceeding 320,000 DWT. ULCCs do not operate in Southeast Asian waters because of draft limitations. Only the Lombok-Makassar route could carry fully laden ULCCs through the islands. There are draft limitations at most of the Asian destinations for oil, such as most Japanese oil ports. So, even if ULCCs could easily transit the Indonesian archipelago, they would have trouble off-loading upon arrival in north Asia. Lightering is possible, but often not cost-effective.

The draft limitation of Malacca does not deter the somewhat smaller VLCCs from using this route. Almost all VLCCs can operate without actually running aground in the Straits of Malacca. The economies of scale of larger ULCCs over VLCCs are lost in this part of the world. ULCCs would be forced to sail a longer route via the Lombok and Makassar Straits rather than the Straits of Malacca, and then face complications when discharging their cargoes at the ends of their voyages. Most ULCCs serve the Persian Gulf to Europe route, via the Cape of Good Hope.

Bulk carriers

Bulk cargoes nearly always move on specialized carriers, which are in general unsuited to transport cargoes other than the commodity they are specifically designed to carry. A small percentage of the world fleet is made up of "combo" carriers, which can carry either dry or liquid bulk. Other than these few combos, bulk carriers are divided into dry versus liquid bulk carriers. These fleets, in turn, are subdivided by the particular type of dry or liquid bulk that they specialize in transporting. Cargo handling and cargo compatibility considerations, as well as varying cargo sizes, tend to reinforce the tendency for individual vessels to specialize in transporting the kind of cargo that they were designed to carry.

A major consideration is cargo-handling capability, which is a major element in vessel design. Time is money, and the faster ships can load and discharge cargoes, the more time they can spend at sea providing transport service. Liquid bulk is the easiest to handle, as it can be pumped, and vessels in principle need not even come along side a quay to load or discharge. Dry bulk may move over the quay on conveyor belts or chutes into vessels, and be scooped out at the port of discharge. Bulk carriers tend to move between ports geared for specific cargoes and specific vessel types.

Chemical and other considerations make transport of some bulk cargoes incompatible with others on the same vessel. It is always possible, but typically financially impractical, to clean vessels between voyages carrying different types of cargo. Petroleum cargoes are generally divided between "clean" and "dirty" cargoes. Crude oil cannot be readily moved in vessels that will later be used to transport certain refined petroleum products, and some refined products are incompatible with others. Coal cannot be allowed to contaminate cement or lime cargoes, as the one is acidic and the other alkaline. Shippers may be hesitant to move grain and other foodstuffs on vessels deemed unclean. These cargo compatibility considerations reinforce the tendency for bulk carriers to specialize in the cargoes that they carry.

Bulk carriers specialize in transporting specific cargoes from area of supply to area of demand. The result is that bulk carriers tend to move to and fro, on either laden or ballast legs. They typically sail from port of origin laden with cargo to port of discharge, then sail empty "in ballast" to a port to pick up a cargo. Whether they can pick up a cargo if repositioning from one route to another is a matter of market opportunity.

Bulk raw materials, such as crude oil, coal, and iron ore, tend to move in large volumes from centralized sources of supply, such as oil fields or mines, to centralized points of demand, such as refineries, electrical power plants, and steel mills. They often travel long distances in large-sized shipments. They are of relatively low value per ton, so they seek the cheapest possible transport. Not surprisingly, these industrial inputs usually move on the merchant fleet's largest bulk carriers.

Finished and semifinished bulk cargoes, such as cement or refined petroleum products, typically travel on small bulk carriers. They often are moving out for distribution to a dispersed market, sometimes into smaller and shallower ports, and desired shipment sizes may be limited by the demand of smaller markets. There is often two-way traffic in such processed bulk, not just the one-way pattern exhibited by raw materials. For example, petroleum product now moves between many nations in Asia, balancing net oversupply in one particular refined product with net undersupply in another.

The counterfactual approach in transportation economics

One builds a concept of how the world works, and collects quantitative data and descriptive information. With the baseline developed about how the world is, change one assumption about how the world works, and trace through the logical consequences of that hypothetical "counterfactual" departure from the baseline.

Appendix C

You may recognize the counterfactual strategy as a variety of "what if" sensitivity analysis. To remain credible, the counterfactual assumptions should be as starkly stated and simple as possible. The logical consequences should be as noncontroversial as possible, at least in terms of the logic train. To avoid turning the analysis into utterly subjective speculation, it is best to stick as close to the facts as possible, and to minimize the use of further assumptions.

In our study, we applied the counterfactual method by first building a database on trade flows and ship movements, and collecting information about transportation costs and trade routes. We then assume that, for some undescribed reason, certain sea lanes are unavailable for shipping. Vessel operators must detour, and are motivated to minimize costs, typically seeking the next shortest available route. We calculated the extra transport costs, and attribute them to the cargoes and trade link. We also kept track of the extra ton-miles of service required, to measure the impact on the balance of capacity supply versus demand.

The farther one departs from the real world, the more the results depend on what one assumed rather than real-world facts. Elaborate econometric models that purport to describe macroeconomies mathematically require elaborate sets of assumptions, about functional form if nothing else. In this study, therefore, we avoided the complicated modeling that would be required to translate the direct transport effects documented here into estimates of the cumulative overall effects.

For diversion, we looked at the short-run impact of a SLOC closure, assuming that shippers have no time to adjust or compensate. We focused on increased "direct" transport costs. We ignore world-trade consequences (such as global commodity shortages) that might add to or compound the effect. We also focused on the immediate impact on shipping costs, as they translate into costs to commodities when they land in port. We did not evaluate the consequent impact on national GNPs or "downstream" markets for the following reasons:

- These are long-run effects outside the scope of the study.
- No uniform econometric model for all nations, appropriate for this task, has been identified.
- The economic profession disagrees on how to evaluate these effects, and the use of "multipliers" is highly controversial (some say "discredited").

- Many economists argue that *no* multiplier effect exists, and measuring the "shock" at the "input level" (dockside) is equivalent to measuring the shock on the "output" level (final GNP).[12]

It is helpful at this point to summarize our analytic framework. We listed and defined the closure scenarios; summarized the basic assumptions of the economic framework; discussed the economics of shipping supply and demand; and, evaluated the short-run economic impact, the scenario's impact on maritime cargo capacity, and freight rates. Finally, we looked at the long-run impacts on shipping cost, and compared port blockages with forced detours on the high seas.

12. See D. Wisecarver, "The Social Costs of Input-Market Distortions," *The American Economic Review*, June 1974.

About the Author

John H. Noer is an economist in the Policy, Strategy, and Forces Division of the Center for Naval Analyses. He earned his Ph.D. from the Department of Economics, and his M.B.A. from the Graduate School of Business at the University of Chicago. He has participated in naval exercises in, and traveled extensively throughout the Southeast Asian region, including the Straits of Malacca, Indonesia, Singapore, and the South China Sea.

David Gregory, who managed the database, supervised the computation of the statistics, and provided administrative support, is a data analyst and computer programmer at the Center for Naval Analyses. He holds a degree in economics from the University of Virginia.

Chokepoints: Maritime Economic Concerns in Southeast Asia

Composed in New Baskerville

Text design and layout by J. C. Owens,
Center for Naval Analyses

Cover design and art
by Lee Woodard, Center for Naval Analyses;
and Juan Medrano, National Defense University